

Economics *of* biodiversity vs. economics *for* biodiversity: valuation of harmful drivers in the Amur Tiger case (Jilin, China)

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presented and publicly defended on 3 October 2011 by:

Joshua Berger, intern at Ecowhat

*Thesis supervisors : **Yann LAURANS, Laurent MERMET***

Jury:

M. Yann LAURANS, Ecowhat

M. Laurent MERMET, AgroParisTech

M. Raphaël BILLE, Iddri

Table of content

FOREWORD ON THE WRITING CONVENTION.....	8
KEYWORDS.....	9
ACRONYMS.....	9
ACKNOWLEDGEMENTS.....	10
EXECUTIVE SUMMARY.....	11
INTRODUCTION.....	15
CHAPTER 1-RESEARCH APPROACH: WHAT POSTURE AND WHAT FIELD.....	20
I. Methodology.....	20
A. Theoretical frameworks.....	20
B. Practical methodology and data to acquire.....	23
1. What data to collect.....	23
a. Identify the agents.....	23
b. Analyse the industry sectors and channels.....	24
c. Understand the rationality and interests of the agents.....	24
d. Study the decision processes.....	24
2. How to concretely collect data on the field.....	25
C. Advocacy by scientists.....	26
1. The possible roles of scientists.....	26
2. The potential pitfalls of advocacy: values, policies and trade-offs.....	27
a. Biased science.....	27
b. Mixing facts and values.....	27
c. Dogmatism.....	27
d. Hidden agenda.....	28
3. How scientists should behave themselves regarding advocacy.....	28
a. Advocacy for policies.....	28
b. Value neutral language.....	28
c. Advocacy for values.....	28
d. Advocacy for advocacy.....	29
4. Arguments in favour of advocacy.....	29
5. Arguments against advocacy.....	30
6. Consequences for our work.....	31
II. Our reference objective: restoration of tigers' habitats and populations . .	32
A. Choice of the reference objective.....	32
B. Sustainability conditions for tigers.....	33
C. Restoration conditions for tigers.....	34
III. Case study area.....	35
A. Environment.....	35
B. History and law.....	36

C. Stakeholders.....	37
CHAPTER 2-LOGICS OF THE DRIVERS.....	39
I. Definition of driver.....	39
II. Typology of drivers and incentives.....	39
A. Intentional and actual management.....	39
B. The three types of drivers: strategic environmental, sector-based and regulators.....	39
C. Need to change the drivers and potential to do so.....	40
1. Economic incentive indicator.....	40
2. Opportunity cost to change to more biodiversity friendly practices.....	41
3. Indicator of the effect on tigers.....	41
4. Use of the typology.....	42
a. Advocacy tool.....	42
b. Technical tool.....	43
III. Analytical accountancy of the drivers.....	45
A. Cattle husbandry.....	45
1. Costs.....	45
2. Minimum herd size.....	50
3. Profit.....	51
B. Crop production.....	54
C. The typical household model.....	54
1. Choices faced by the household: a dashboard for visualization.....	55
2. Revenue formation.....	58
3. Reliance on income sources.....	61
4. Special cases.....	64
IV. Classification of drivers in Hunchun.....	64
A. Caveat: the polyculture structure.....	64
B. Decision rules for the typology.....	64
C. Cattle husbandry.....	65
1. The additional issue of compensation.....	66
2. Characterisation.....	68
a. Husbandry with forest pastures and with compensations.....	68
b. Husbandry with forest pastures and without compensations.....	69
c. Husbandry without forest pastures and without compensations.....	69
d. Stall-feeding.....	70
C. Crop production.....	71
D. Frog breeding.....	73
E. Forest exploitation.....	73
F. Bee keeping.....	74
G. Non Timber Forest Product harvesting.....	75
H. Poaching.....	75
1. Poaching of tigers's preys.....	76
2. Poaching of tigers.....	76

I. Road and railway building.....	78
J. Influence of perverse incentives/subsidies on the drivers.....	80
1. Definitions.....	80
2. Reasons to implement subsidies and why they can be harmful.....	81
3. Compensation for wildlife damage as an harmful incentive.....	82
4. Free forest pastures as an harmful incentive.....	83
5. Crop production subsidies as an harmful incentive ?.....	83
K. Summary of the classification for all the drivers.....	83
V. Chapter conclusion: our method contribution and strategic insights.....	89
CHAPTER 3-THE “ECONOMIC ASSESSMENT OF BIODIVERSITY”	
APPROACH.....	91
I. Assessing the value of ordinary or exceptional biodiversity ?.....	91
II. What economic assessment of biodiversity can bring to conservation ?.....	92
A. Ecosystem service valuation.....	92
1. Decisive assessment.....	93
2. Technical assessment.....	93
3. Informative assessment.....	93
B. Exceptional biodiversity valuation.....	93
C. Underlying model of decisions.....	94
III. Where does the value of biodiversity could and actually play in the logics of the drivers ?.....	94
IV. What values for tigers beyond the economic value ?.....	97
CHAPTER 4-HURDLES TO IMPLEMENT A CONSERVATION POLICY	
BASED ON ECONOMIC EVALUATION IN HUNCHUN.....	99
I. Economic evaluations need to be perfected.....	99
II. The decision-making context is not favourable to the use of economic evaluations.....	100
A. Assumptions.....	100
B. Test of these assumptions in Hunchun.....	101
1. Insufficient economic education assumption.....	101
2. Non conducive regulatory framework assumption.....	101
3. Decision processes that need obscurity or ambiguity assumption.....	102
III. A conceptual problem : economic valuation of biodiversity is not always fit nor needed.....	103
A. Not fit: political choices that will not be changed by economic valuation...	104
B. Not needed: economic valuation does not bring key elements to the decision	
.....	104
1. Decisions based on trade-offs between values.....	104
2. Economic valuation has little operational value.....	105
C. Economic valuations of biodiversity useless ?.....	106
IV. Economic incentives and economic valuations.....	107

A. Efficiency and relevance of economic incentives.....	107
B. Compensation and stall-feeding programs in Hunchun: perverse incentives	108
C. Bee keeping in Hunchun: a failed incentive.....	109
CONCLUSION.....	110
BIBLIOGRAPHY.....	114
APENDIX A.INCOME SOURCES.....	120
APENDIX B.OTHER CASE STUDIES FROM LITERATURE.....	122
I. Hidrovia.....	122
A. Situation.....	122
B. History.....	124
C. Advocacy.....	124
II. Elwha.....	126
A. Situation.....	126
B. History.....	127
C. Advocacy.....	129
APENDIX C.COMPARISON OF SPENDINGS FOR PRODUCTIVITY AND TO PROTECT BIODIVERSITY IN AGRICULTURE.....	131
INDEX LEXICAL.....	133

Table of tables

Table 1-Economic activities related to tiger conservation (WCS Russia n.d.; B. Li et al. 2009; WWF et al. 2010; Quach et al. 2010).....	12
Table 2-Brief list of the incompatible drivers and how they threaten tigers.....	33
Table 3-Economic incentive indicator typology.....	40
Table 4-Use of the economic incentive indicator to advocate for biodiversity.....	42
Table 5-Classifying the drivers to see how to change them.....	44
Table 6-Consumption of feed per head of cattle and per day reported by villagers.....	45
Table 7-Control of data about consumption: straw available.....	46
Table 8-Comparison of consumption figures with France and summary of figures for the consumption per head and day we keep for the rest of the analysis.....	46
Table 9-Costs really borne by farmers, including opportunity costs.	47
Table 10-Costs to raise cattle per head and year.....	48
Table 11-Calculation assumptions to find the minimum herd size.....	51
Table 12-Profit break down for cattle husbandry (the letters into brackets refer to table 10).....	52
Table 13-Costs (RMB/ha) of growing crops.....	54
Table 14-Gains of growing crops (source: villagers in Lanjia except for price of corn and soya: internet).....	54
Table 15-Decision rules to classify drivers into one or another of the categories.....	65
Table 16-Expected (theoretical) use and non-use values of the tigers (exceptional biodiversity) and forest ecosystems (ordinary biodiversity), adapted from TEEB (2010).....	92
Table 17-Expected uses of economic valuation of biodiversity applied to Hunchun and its actors..	95
Table 18-Comparison of amounts spent on subsidies for productivity or for biodiversity	

conservation.....	131
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Table of figures

Figure 1-Synthesis of our research approach and logic.....	17
Figure 2-Hunchun National Nature Reserve localisation. Source: B. Li et al. (2009).....	35
Figure 3-Opportunity costs – adapted from Laurans, Leménager, et al. (2011), citing Wunder (2005).....	41
Figure 4-Cattle killed by tigers in Hunchun - Data from 2002 to 2007 are from B. Li et al. (2009) and from 2008 to 2010, they are from discussions with the Compensation Bureau of Hunchun.....	49
Figure 5-Extension of the analytical accountancy: a dashboard to visualize data.....	56
Figure 6-Illustration of the analytical accountancy dashboard with cattle husbandry. External source: Banshi's people government (2011).....	57
Figure 7-Comparison of cumulated money fluxes for traditional cattle husbandry and stall-feeding.	58
Figure 8-Monetised fluxes and non-monetised services and how they form livestock husbandry revenue for a typical household.....	60
Figure 9-Household's reliance on each source of income.....	62
Figure 10-Profit break up by activity for the typical Hunchun household.....	63
Figure 11-Market and government intervention failures (reproduced from Barde & Honkatukia 2004, p.4)	81
Figure 12-Hunchun's drivers' economic incentives (compatible drivers in green).....	85
Figure 13-Hunchun's drivers' technical classification to determine if and how to act on them.....	87
Figure 14-Hidrovia's situational map (source: Gottgens et al. 2001).....	123
Figure 15-Elwha situational map (source: Warrick 2005).....	126

Foreword on the writing convention

Words in *blue italic* are key words defined in the thesis. You can report to the “Definition index” at the end of the thesis to find the page where such a word is defined. Words in *brown italic* are key words undefined because they hold their usual meaning in the thesis. Citations are in *dark grey italic*. Sentences or words we want to emphasize are in **bold** or underlined if they deserve particular emphasize.

Keywords

biodiversity; advocacy; economic valuation; adversaries of biodiversity; use of economic valuation; Strategic Environmental Management Analysis (SEMA); economic incentive; Amur Tiger; China; Hunchun; Hidrovia; Elwha

Acronyms

DM: Dry Mater

NGO: Non Governmental Organisation

NTFP: Non Timber Forest Products

PES: Payment for Environmental Services

SEMA: Strategic Environmental Management Analysis

TEEB: The Economics of Ecosystems and Biodiversity (TEEB 2010)

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Executive summary

This executive summary is aimed at providing environmental NGOs and decision-makers involved in environmental decisions with insights on how to employ economic tools to analyse an environmental issue and try to resolve it. In particular, it uses the example of Amur tiger conservation and outline how to design *relevant* and *efficient* economic incentives (such as subsidies or community programs that support households to engage in a new activity) to address environmental issues.

Analysis framework

Our analysis is centred on an environmental issue and seeks to resolve it. Accordingly, the results of the analysis are explicitly aimed at people who protect the environment. Our work falls within the *strategic environmental management analysis* approach (Mermet 2011). It therefore places a focus on the **conflicts** and **strategic** aspects of environmental issues.

We studied the organized groups and divergent interests that surround Amur tiger (*Panthera tigris ssp. altaica*) conservation. In order to define whether economic activities are detrimental or favourable to tigers, we were required to explicitly define what we considered as the conservation objective:

A self-sustainable population of Amur Tigers reconquering its original historic range i.e. ranging from Russia Far East to North Korea in the south and Mongolia in the west¹.

This long-term objective (referred to as the *reference objective*) was chosen because of its ethical foundation (human actions caused the retreat of Amur tigers out of their original range) and its operational and strategic values. Most environmental actors we met indeed have this aim in mind (D. G. Miquelle et al. 2001). Therefore an analysis that outlines how to reach it will be valuable to them.

Another reference objective would certainly bring different results. In effect, the objective determines what economic activities are considered as *synergistic*, *incompatible* or *compatible*. They respectively go in the same direction as the objective (i.e. increase tigers' populations and habitats), in the opposite direction or do not affect the objective. With our *reference objective*, corridors to let tigers expand to new territories are needed and as a consequence some areas that grow crops are *incompatible*. If we aimed only at the conservation of current habitat, they would be *compatible*.

Case study area

Hunchun city, China, belongs to Jilin, one of the two provinces in China where Amur tigers are present. They are protected internationally and are IUCN red listed. Amur tiger trade was banned in China in 1993. Hunting of any species and the use of guns are prohibited in Jilin. Hunchun Natural Reserve was established in 2001 and subsequently upgraded to the National status in 2005. Human activities are in theory prohibited inside its core zone but local authorities tolerate them (e.g. it is illegal but considered “reasonable” to let cattle graze there).

The main source of income is in average derived from crop production. For most households, it is complemented with cattle husbandry, Non Timber Forest Product (NTFP) harvesting and sometimes part time jobs (Chin 2011). We reproduce here a list of major activities and their impacts on the

¹ (Miquelle et al. 2010)

tigers.

Table 1- Economic activities related to tiger conservation (WCS Russia n.d.; B. Li et al. 2009; WWF et al. 2010; Quach et al. 2010).

Activities	No harmful effect	Reduce habitat	Indirectly increases mortality of tigers	Directly increases mortality of tigers
Cattle husbandry		x	x	
Poaching of tiger preys			x	x
Poaching of tigers				x
Crop growing		x		
Frog breeding			x	
NTFP collection			x	
Forest exploitation	x			
Bee keeping	x			

Cattle husbandry

Two main forms of husbandry can be distinguished: **traditional cattle husbandry** and **stall feeding**. The former benefits from collective (village owned) and State pastures located mostly inside the forests in areas cleared of trees. Cattle spend 7.5 months of a year inside these pastures at no cost to the farmer. Ungulates inhabiting the forests may suffer from diffuse competition with cattle grazing in the forests and above all, they are **disturbed by human presence** as farmers sporadically check their cattle in the forest (Prins 2000). This results in reduced ungulate population size and as a consequence the number of prey available for tigers decreases. Therefore cattle husbandry is considered *incompatible* with the *reference objective*. This system also implies that farmers only have to feed their cattle for 4.5 months of the year and they usually provide cattle with feed transformed from their own crops (soya bean, corn flour and corn straw). Microeconomic data collected revealed that transformation costs (e.g. from soya to soya bean) are extremely low, whereas **the opportunity costs of not selling crops are significant** and constitutes the bulk of the total costs for the household as a whole: **they tip the profit into loss**.

Compensation awarded by the government to farmers when they suffer a loss of livestock from tigers does not **on average** present a notable effect on the profit (but it can bring profit back to 0 if losses represent 5% of the herd every year, against 0.2% in average [B. Li et al. 2009]; and it can psychologically support farmers who suffered from a loss).

Our analysis unveiled a non-intuitive result: public policies' main support to husbandry is not monetary but non-monetary i.e. it does not consist of money awarded to or taxed from farmers. Instead it consists of provisioning services (Millennium Ecosystem Assessment 2005) provided by the forest pastures to farmers for free. When these pastures are State owned and especially when they are located in the core zone of the Reserve, they are akin to *harmful subsidies* that increase environmental damages compared to a situation where free grazing would not be allowed. Interestingly, we note here a **conflict between those ecosystem services** (fodder provisioning) **and a part of the biodiversity**: ungulates and tigers.

To demonstrate the importance of free pastures, field microeconomic data collection was indispensable: it would not have been possible to extrapolate it through aggregated measures.

The method of linking ecological data with economic data, though not new, brings about very

interesting strategic insights: cattle husbandry's incompatibility with the *reference objective* stems from the pastures inside the forests. It does not constitute a “negotiable” incompatibility. Meaning, husbandry cannot renounce to those pastures to become *compatible* and stay profitable. As a consequence, all kinds of husbandry, stall feeding included, are *incompatible* and should not be promoted. It is thus not possible to lead an **ecological intensification**. In addition, we demonstrate that on average, compensation plays a minor economic role and indicate that focus of environmental actors should shift to the prohibition of forest pastures or, even better, to other *incompatible* drivers.

Utilizations of economic valuations of biodiversity (EVB)

As the logical continuation of the work conducted by Laurans, Mermet, et al. (2011) where they listed all potential uses of ecosystem services valuations (UESV) and reasons to explain why there were only very few mentions of decisive uses in the environmental economics literature. We extended their work to all EVB and listed potentials uses of EVB (UEVB) and their users in Hunchun.

We then compared this potential list to the EVB actually used in the Amur Tiger case: only one apparent and obvious use was discovered: a (partial) evaluation of the use value of Amur tigers based on ecotourism and tiger-friendly products. This UEVB is planned and has not yet been delivered.

None of the EVB we spotted in the scientific literature (Bi-han & Ji-xun 2005; Wu et al. 2002; 王宗明 et al. 2004; Zhou et al. 2009) was used and their authors did not mention any expected use in their articles either.

Why were we unable to observe UEVB ? We lacked time and resources to meet most of the decision makers and acquire documents related to decisions. Consequently we may have missed some UEVB. We can however affirm **there is no evident and easily accessible UEVB**. Laurans et al. (2011) identified a series of possible reasons for the absence of UESV. The following **set** of reasons could be applicable to the Amur Tiger case: **(1)** economic evaluations need to be perfected to correct *inaccuracy* and *incompleteness* issues and **(2)** the decision context does not favour EVB: **(2.a)** decision-makers lack economic education, **(2.b)** regulatory frameworks are not conducive and **(2.c)** decisions sometimes need obscurity and ambiguity, they thus avoid the transparency (e.g. on the distributions of costs and benefits between agents) brought about by evaluations. All these reasons play an important role in Hunchun. One additional explanation is that decisions are based on trade-offs between values. The economic value of biodiversity represents only one of these values and cannot be decisive alone.

EVB also offer little operational value: they do not indicate which drivers threaten biodiversity (which is the role of ecology) or how these drivers can be changed. Nor do they provide indications on how to adjust economic instruments to protect biodiversity. For instance, the amount paid to households that benefit from Payments for Environmental Services (PES) are not based on the value of these services (indeed no assessment of their values are conducted [Landell-Mills & Porras 2002]) but on the opportunity costs households face to protect these services. It is thus economic evaluation of the adversaries of biodiversity rather than EVB that provide data (such as the opportunity costs) to adjust these instruments.

Use of economic valuations to design relevant and efficient economic incentives

Despite the unwillingness of some agents to use economic evaluations, some minority environmental actors may want to assess economic activities that threaten biodiversity. Subsequently they may do their accountancy to reveal how efficient economic incentives can be

designed to make them change.

However it is first necessary to determine which activities to target to be *relevant*. Ecology, and not economics, fills this work and establishes causality links between human activities and impacts on the ecological conditions that need to be maintained to reach the *reference objective*. Once it is clear which activities are incompatible, they can be directly or indirectly targeted.

To be *efficient*, the economic incentive **(1)** must - at the right time² and place - act on inputs (workforce, assets such as tractors, etc.) used by the target incompatible activity. For instance, if poaching is the target, an incentive that requires time in summer is not *efficient* because poaching requires workforce only in winter. **(2)** It must tip the economic balance in favour of a compatible activity. I.e. the profits of the compatible future activity must be superior to the current incompatible ones. **(3)** The temporal structure of gains associated with the activity promoted by the economic incentive also needs to satisfy and be attractive for the target households.

2 In our thesis, we insisted on the temporal aspect but neglected the spatial aspect although it also represents a key element: incentives must act at the places where they are required.

Introduction

Not so long ago, governments would send the police to quell environmental demonstrators opposed to dam projects. Nowadays, a highway construction may need to adapt or even stop because a “miserable” (in the words of some people) beetle lives in a little-known forest just in the way that was initially planned. What a pity some may think. Other may rejoice that we are now able to take more into account the environment into decision-making. And they believe that **economic valuation of biodiversity** can help to ensure that more and more often.

“Because these services [the services of ecological systems] are not fully captured in markets or adequately quantified in terms comparable with economic services and manufactured capital, they are often given too little weight in policy decisions.”

(Costanza et al. 1997)

If we follow this citation and the spirit behind the well-known estimation of the value of Earth's ecoservices by Costanza et al. (*op. cit.*), quantifying ecoservices in terms comparable with economic activities would allow to give them the weight they deserve in policy decisions. This position has been further developed and explained in The Economics of Ecosystems and Biodiversity (TEEB) and the famous citation of its study leader:

“You cannot manage what you do not measure.”

Pavan Sukdhev

So one of the aim of the TEEB was to give values to ecosystem services clearly defined and classified such as provisioning or cultural services (Millennium Ecosystem Assessment 2005) so that the value of these services was no longer a per default zero in decisions (TEEB 2010).

However, an article analysing utilisation issues of economic valuation of biodiversity, and from which my work is one extension (they belong to the same research program), questioned the actual use of such economic valuations of biodiversity in decision-making (Laurans, Rankovic, et al. 2011). Are economic valuations of biodiversity really used by decision and policy-makers to measure the relative benefits of different projects or options within a project and then choose the one maximising social welfare ? What other uses can they have ? And can we indeed find examples of such other uses ? The literature rarely address these questions and it seems hard to find proofs of their decisive uses.

At the same time as this focus on ecosystem services developed, more and more attention has been paid to human societies' influence on biodiversity. One idea pushed forward is that economic activities threatening biodiversity are not passively and inevitably moved by the invisible forces of the market, without any intention or organisation (Mermet 2011). They are at the opposite organised forces that are able to collectively face threats to their activities and fight those threats in order to maintain the “business as usual” situation. To make it clearer, we can take the example of mountain roads built to exploit forests. Some analysis of the threats that faced bears in the French Pyrénées may have mentioned “habitat fragmentation” and the building of these roads indeed fragment bears' habitat. But is this a blind fragmentation (or is the deforestation in the Amazon a blind fatality that cannot be avoided ?) or the results of an activity sector that - from the protection of bears standpoint at least - should be opposed ? Actually, when road building is opposed, the agents behind it resist and strategically adapt their discourse and actions: they will for instance provide different options to

build a road like a short road, a long road and a cable to pull wood from production site to an existing road and will then use different tricks to discredit the best environmental solution (the cable) and act as if they had compromised by eventually choosing the short road option - which is actually the best option for some agents - (Mermet 2003). This example illustrates the organisation behind concepts like “deforestation”, “habitat fragmentation”, etc. It shows we cannot just consider these concepts to understand and solve an environmental issue but that we have to go behind them and study the activity sectors threatening biodiversity and keep in mind that they are acting strategically and will respond and adapt to environmental pressures. Another idea regarding these threats to biodiversity that is gaining ground, especially since the Nagoya Convention on Biological Diversity in 2010 is the one of *perverse incentives* and especially *perverse subsidies* from governments that would negatively impact biodiversity.

“Government subsidies that encourage biodiversity decline can be quantified financially, and represent a clear opportunity for policy reform to promote the objectives of the Convention. Notwithstanding the need to address all perverse incentives, in the first instance it is recommended to concentrate on identifying government subsidies with perverse effects on biological diversity.”

SCBD (2000), quoted in Bagnoli (2003)

The **main idea** of our thesis is to **study the idea of reversing the burden of the proof in strategic struggle about environmental issues**. Currently, it is the beetle that has to prove its value if one wants the highway to change its initial path and avoid the forest (to repeat our initial example). Reversing the burden of the proof would imply that the highway has to prove its value to be allowed to be constructed. Is this kind of argumentation more efficient to protect biodiversity ? Is it more useful for decision makers to know the integrative (creation of social value) and distributive (who gains, who loses) values of activities threatening biodiversity than to know the value of biodiversity itself ? Our reader may think that anyway economic activities **always** make money (otherwise why would someone bother to conduct these economic activities ?) so our reasoning will lead nowhere and will be toothless. If all economic activities earn money, then they can always prove their value and they should always be allowed. Actually, our reader should take a fresh look at the problem because some activities benefit from huge public support and financing even though they can induce losses for many agents. That is the case for some mountain roads in France (Mermet 2003) where the Forest National Office (ONF in French) and the town globally lose money on the project; that is also the case for some mountain farms in Europe that would not survive without the Common Agricultural Policy support that transform their loss into a slightly positive profit. So even without considering the social benefits, it should be possible to show that private benefits are negative or low for some activities threatening biodiversity (and that they could be higher if other activities were pursued). In this context, it is especially interesting to keep an eye on possible *perverse incentives* from governments that would at least promote but maybe keep alive activities threatening biodiversity.

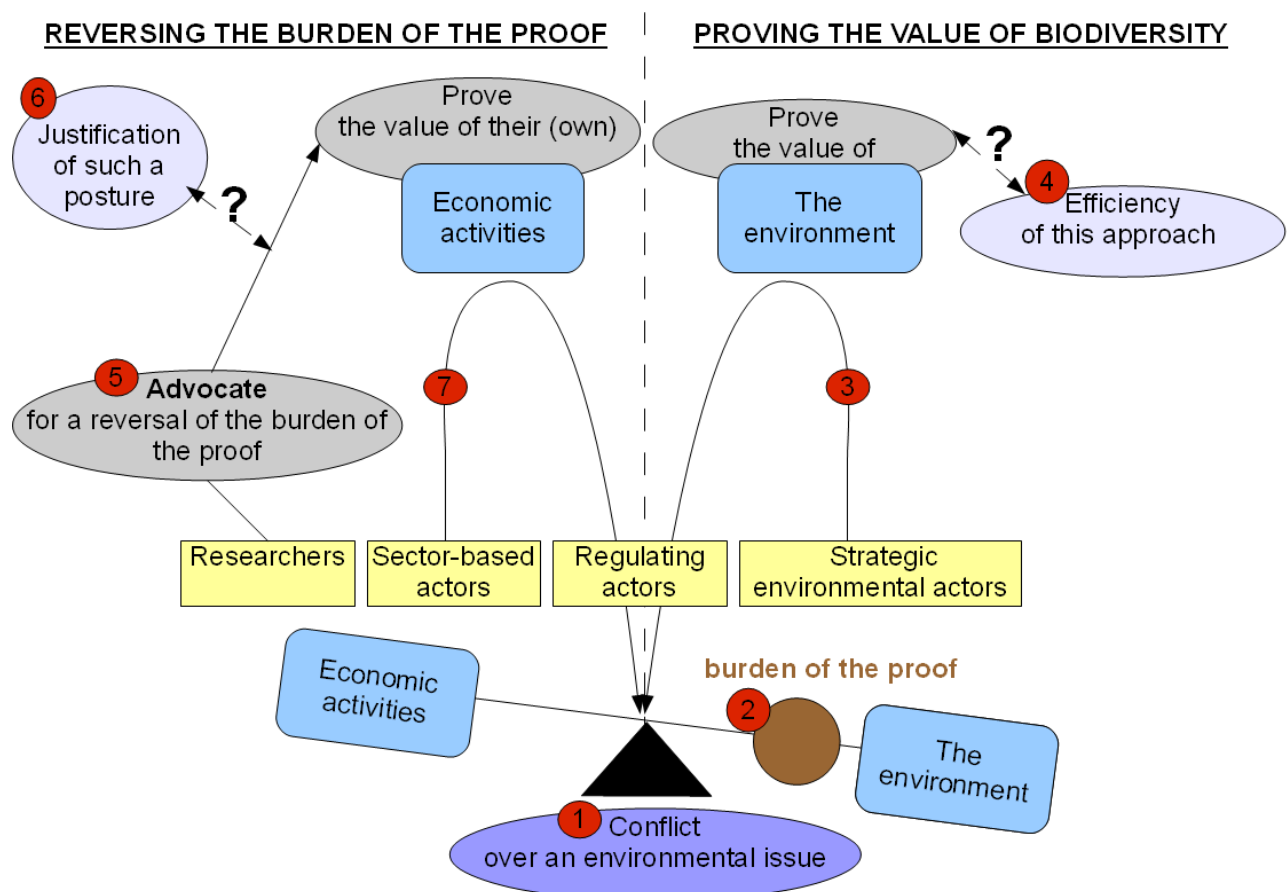


Figure 1- Synthesis of our research approach and logic.

In the figure, actors are in yellow, the action they have to undertake in grey, questions related to these actions in pale-blue and the two elements (the environment, economic activities) that may need to be justified in blue. Here are the explanations related to the numbers in the figure :

1. Our study is focused around an environmental issue that we define.
2. In the right side of the figure, the burden of the proof (represented as a brown mass that tip the balance in one side or the other) to prove that the situation needs to change is borne by the environment. So the balance is in disfavour of the environment.
3. *strategic environmental actors* (the ones who act in favour of the environment, see **Chapter 2, II. B.** for more detailed definitions of the classification of the actors) have to prove the value of the environment (eg they have to prove that the beetle or its habitat indeed possess value). If the value is proven, it is assumed that the *regulating actors* (“a rule-based or rule-making mediation or authority” [Mermet 2011]) will take it into account in their decisions.
4. In **Chapter 3 and 4**, we question the efficiency of this approach which assumes that an evaluation of the value of biodiversity allow to take it into account in decisions.
5. Our thesis is that a reversal of the burden of the proof may be more efficient to reach conservation objectives. So as a researcher we are advocating for such a reversal and we evaluate its do-ability. By doing so, we actually act as a *strategic environmental actor* (but researchers are on the left of the figure because we describe their actions related to the reversal of the burden of the proof).
6. We discuss the justifications of such a posture in **Chapter 1, C. Advocacy by scientists** : is it the role of scientists to be advocate ?
7. If the burden of the proof falls on economic activities, then sector-based actors need to at least prove they are profitable (we do not discuss the fact they should also create social welfare because it would imply to assess the value of the environment and to put again the burden of the proof on the environment).

Our research is articulated around three main questions. **First**, in order to determine whether or not economic valuation can help to advocate against them, we need to know **what are the characteristics of the *adversaries of biodiversity***, ie the activity sectors that threaten biodiversity ? What are the different kinds of incentives that drive them to threaten biodiversity ?

Second, we **question the use of economic valuations of biodiversity**. Economic valuations are supposed to demonstrate the value of the environment brings to society through services or through other values such as its mere existence, it is then supposed to let stakeholders weight the benefits and the cost of keeping or removing this value of the environment. If we look at the economic literature at least, it seems that economic valuations of ecosystem services are not decisively used (Laurans, Rankovic, et al. 2011), though they may present informative uses. So why do we keep destroying our environment without assessing its value to show that this destruction decreases social welfare ? Is it because of problems linked to the quality of the evaluation itself and so its perfection would be needed (for instance by including distributional aspects) ? Or is it because decision-makers and decision-making context is not favourable to the use of economic evaluation of biodiversity ? Maybe the problem is not one of a blind system that do not take the environment into

account because it does not see its value. If that was indeed such an **information problem**, economic valuations would probably be the solution. But the psycho sociologist David Uzzel³ explains that psychology studies have revealed information does not trigger behaviour change alone; for instance knowing that tobacco is bad for health does not prevent people from smoking. So may it be a problem of divergent, **conflictual interests** (Mermet 2011) instead of a **cooperation** problem ? It may also be that economic values are not alone in town and thus decisions are influenced by other values, making economic valuation not as useful as expected.

Third, to push the idea of the first main question further, **is it possible to change the economic incentives faced by *adversaries of biodiversity* to implement effective conservation policies ?** How to change the right economic incentives ? What happens if the concept is good but the implementation bad ? Is it possible that some drivers which threaten biodiversity are sometimes too well established and hard to change through economic incentives alone ? Can other tools such as regulation and information help ?

To answer these questions, our support was economic literature about *perverse incentives*, advocacy by conservation scientists and economic valuation of biodiversity. We conducted a case study in Hunchun city, Jilin province, China, about the economic activities that threaten the **Amur Tiger** (*Panthera tigris ssp. altaica*) to improve, test and illustrate our hypothesis and analysis. Our work falls within the *strategic environmental management analysis* approach (Mermet 2011) that places a focus on the conflictual and strategical aspects of environmental issues.

In **Chapter 1**, we describe our research methodology and theoretical foundations, the baseline on which is based our analysis and provide context elements about our case study area. In **Chapter 2**, we focus on the economic activities of our case study area, so we first develop a typology to classify them, then analyse the data we collected on the field and eventually classify these activities to see which ones are negative for our environmental concern, how to advocate against them and we deal with the question of a change of economic incentives to implement conservation policies. In **Chapter 3**, we consider the role of economic valuation of biodiversity, its supposed uses and its actual uses. And in the final **Chapter 4**, we focus on our second research questions (*supra*) and try to understand why economic valuation of biodiversity is not used. We also sum up two case studies from the literature to demonstrate that our case study's results are not unique in **Appendix B**.

3 <http://www.iddri.org/Activites/Seminaires-reguliers/Seminaire-Developpement-durable-et-economie-de-l-environnement/Psychology-and-Sustainable-Development-Beyond-Behaviour-Change>

Chapter 1- Research approach: what posture and what field

In this first chapter, we describe the theoretical foundations on which we build our research. To illustrate the concepts we developed to advocate against economic activities threatening biodiversity, we lead a case study about activities threatening the **Amur Tiger** (*Panthera tigris ssp. altaica*) in China's Hunchun city in the North East province of Jilin (吉林). After describing our methodology, we define the *reference objective* for Amur Tigers against which we will analyse the current situation. Finally, this chapter is closed by a description of relevant characteristics of our case study area and its stakeholders that will help the readers understand our analysis and data in the following chapters.

I. Methodology

A. Theoretical frameworks

Our work is part of a an approach developed for over 20 years that acknowledges the conflictual essence of environmental issues and explicitly analyses the strategies of the different stakeholders, pro or against the environment: the *strategic environmental management analysis* (SEMA). By caricaturing a little, we could summarize some other approaches to environmental issues as: "let us all gather around the table and we will find a win-win solution together". SEMA rejects the idea that the major changes in resource exploitations needed to solve major environmental issues can be obtained by gathering together stakeholders that had, have and will have divergent interests. Being all together around a table does not make opposed interests disappear. We quote a paragraph explaining how the SEMA approach shapes the analysis from a very comprehensive summary of the approach:

“In the diagnostic approach to environmental issues [SEMA] guides analysis by (re)framing along five lines: (1) separating clearly the actual management of the ecosystem (even if it seems bad enough to constitute no management at all) from the intentional management (that is, those interventions that aim mainly at improving the ecosystem’s condition); (2) devoting separate and distinct attention to those stakeholders acting in favour of solving the environmental problem at stake; (3) analysing other actors in clear view of the activity sectors they are involved in – sectors that structure in a multi-scale fashion the way natural resources are exploited and environmental impacts are generated; (4) paying explicit attention to the adversative dimension of environmental (and anti-environmental) strategies; and (5) founding strategic analysis on one (or a small set of) inevitably somewhat contingent, but clearly defined, environmental concern(s).”

(Mermet 2011)

We explicitly follow the citation's five lines all along our analysis and here are, point by point, our answers to them: **(1)** we separate the actual and the intentional management of Hunchun ecosystems in the section **Intentional and actual management** (Chap. 2 II. A). **(2)** those

stakeholders acting in favour of the environment are described in the **III. Case study area** of this chapter and we explain their expected role in the SEMA framework in **The three types of drivers: strategic environmental, sector-based and regulator (Chap. 2 II. B)**. (3) is the bulk of our thesis as we focused on those adversaries of biodiversity, the **Chapter 2** is mainly dedicated to their analysis. (4) our thesis is designed to evaluate the potential of a reversal of the burden of the proof in debates about environmental issues (instead of asking to biodiversity to prove its value, it can be asked to its adversaries to prove theirs). These debates are actually strategic struggles where some groups want to change the current situation and other want to keep the *status quo* and we indeed paid attention to the adversarial dimension so our analysis eventually presents tools to *advocate* in favour of the environment. (5) This is one key point: our analysis is contingent to the environmental concern we chose and we describe it in the **II. Our reference objective: restoration of tiger's habitats and populations** of this chapter.

By choosing this theoretical framework to guide our research and further through the choice of our reference environmental concern, we deeply affect the possible **use of our research**. Clearly, if one wants to know how it is best to improve villagers' living conditions in Hunchun's area, our thesis will be of little if no help to him. If one wants to restore tigers' habitats and populations, then our thesis provides helpful tools to reach this aim. Even though it leads to **partial** results, both in the sense that they are incomplete and represent only an aspect of the problem and in the sense that they are biased, influenced by our *reference objective* and its associated normative values, we assume this partiality and believe such a research posture is justified. It is **justified** because any analysis has its normative value and analysing all the potential aspects we can think of (eg ecological, economic and social) would not mean our analysis conveys the truth. Moreover, the different aspects are sometimes not compatible or even contradictory so it may be hard or impossible for the analyst to deal with them equally because of his own beliefs and values. Unlike Taravella (2008) who writes that it is utopian and impossible to try to encompass and analyse all the aspects of a problem, be it all at once or successively, we believe it may be possible to do that successively but it does not have more value than to shed light on only a partial aspect of the problem. Our posture is further and above all justified because an analysis cannot be useful for everyone: it will help some more than others and may actually hinder those others. Because of this, stakeholders will be more or less willing to collaborate with the researcher and to provide him with data. This is especially true when we deal with environmental issue with huge distribution issues at stake. By trying to be neutral and help everyone, the researcher will restrict its ability to get interesting and strategic data whereas an assumed partial viewpoint will help him get data from the stakeholders he tries to help. However, the most useful data may be those detained by the ones who may suffer from the researcher's analysis, that is to say the people who should be the less willing to provide the researcher with data. We deal with this in the next section.

To further clarify what our thesis did and what it did not, which itself determines its possible use and the research still needed, it is interesting to have a look at the concepts laid out in Laurans (1997)'s Ph.D. thesis. Laurans shows how an environmental issue (in his case climate change) is usually analysed using one or two out of three possible conceptual models. These models are:

- the *environmental issue model*: it compares the *de facto* situation with a desired situation defined by the modeller in terms of use of an environment common good. Its features are the description of the two situations, of individual behaviours, their coordination and their outcomes. It shows the gap between the two situations and also present solutions to bridge the gap.
- the *collective action issue model*: when there is a change in the established order, such as new rules for collective action (eg one activity is forbidden), *interests* - used here in the

sense of gains or losses - of agents appear. This model represents the possible *scenarios* of change and the associated interests. It aggregates the outcomes of the different possible actions by all the agents and the interests that result from these combinations. It also draws assumption regarding the **rules** governing agents' behaviour, ie how they should make choices.

- the *decision system model*: it describes the *processes* and *modalities* through which agents reach decisions regarding collective issues. For instance, in the specific context of negotiation, it considers **structural variables** such as the number of groups of agents, the importance of future relations between agents (do they have to care about future encounters or will they never meet each other again), the power differences, the context (place, public or private decision, framework) and the strategies deployed by the agents (cooperation/defection, coalition, pledges threats, etc...). It also describes the **decision processes** themselves: mutual concessions process ? joint resolution of technical issues ? It pays attention to the **results** too: how gains are distributed and evaluated ? Are agents personally satisfied ? Do they feel the decision was fair or just ?

Laurans (*op. cit.*) argues that a better understanding of how to solve environmental issues can be reached by feeding each model with the others. He suggests to use first one model as an entry point to a problem, push its conclusions to their ends and then use them to study the problem with another model, then use the results of this second model in the first model, creating a feedback loop that brings some changes such as corrected or new hypothesis which consequences can be analysed and tested.

We did not entirely follow this program but the three models we just described help us realize more clearly that our analysis is mainly based on the **environmental issue model**: we describe a gap between the *de facto* situation and our *reference objective* (defined later in this chapter) and we also describe individual behaviours and their outcomes. We also partially modelled the situation through the **collective action issue model** since we depicted the gains and losses of different agents in the current situation and in the hypothesis of a change towards the *reference objective* (see **Chap 2 III. Analytical accountancy of the drivers** and **IV. Classifications of drivers in Hunchun**, especially the opportunity costs we defined to change practices and reach a *future activity* more *compatible* with the *reference objective*). However, we did not push the modelling very far and did not describe the behaviour rules of agents nor an exhaustive range of scenarios. We did not model the decision system either. That is a choice we had to make because of the limited amount of time we had. The first model (the environmental issue model) is a logical entry into the problem and in our perspective of showing that adversaries of biodiversity can be opposed through economic valuations, we first need to understand who they are, why they are incompatible with the *reference objective* and why they act as they do. But to further test our results and determine if the burden of the proof can really be reversed, we would need to study the **decision processes** and find out if arguments about a lack of values of projects or activities threatening biodiversity are of any use to decisions (for an example of such an approach, please refer to the Master thesis of Haddad 2011).

A third approach that inspired our research are the works by Mermet and his research team about dams and mountain forest roads (Mermet 2003). I faced similar issues as theirs, such as how to measure the interests of stakeholders ? They identified that costs-benefits analysis can be a starting point for such a work but that such analyses concentrate on integrative aspects (how value is created for the collective group) and not on distributive aspects (how values is shared inside the group), though it is the distributive aspects that determine the interests of stakeholders. So they built on the idea of an *analytical accountancy* (that pre-existed their works): **an accountancy produced to meet the particular needs of an analysis** and that therefore considers only a portion of all the data

available but is more useful to answer some specific questions than the public accountancy for instance. We more or less developed such an *analytical accountancy* when we studied the costs, earnings and money transfers of the drivers (see **Chap 2 III. Analytical accountancy of the drivers**).

B. Practical methodology and data to acquire

How the theoretical frameworks we just described translate themselves in the field ? During the two month and half I spent in Hunchun city (Jilin province, China), what data was I supposed to collect to answer my research questions ? And how to collect these data ?

1. What data to collect

Keeping in mind what the SEMA approach advises, such as to pay attention to the strategic components of agents' behaviours and to distinguish what agents do to consciously manage the environment and what they do that indirectly impacts the environment, we initially planned to collect data for the three models described previously Laurans (1997):

- (a) identify the agents for the **environmental issue model**.
- (b) understand the rationality and interests of the actors to build the **collective action issue model**.
- (c) study the decision process for the **decision system model**.

It is worth noting that unlike previous works using the SEMA approach, **our work does not study a project** (eg a construction project) carried by an agent but instead it studies an animal species. At first sight, while a project implies that agents' interests are changing because the situations before and after the project are different, the study of an animal and its link with human agents is **static**: how do they influence each other at a given point in time. Therefore, there may be no negotiation over the best ways to conduct the project (indeed, there is no project) and not a unified frame (the project) that would concentrate all the actions and decisions. Because of this second point, it may be hard to analyse the situation as many different decisions linked to the animal but otherwise unrelated may have been taken and the analyst has few elements to link them. So the tools that have been developed by practitioners of the SEMA approach to study projects might not be fit for our study. However, we can also create a fictional project (and we do not need to have it carried by any agent, it can just be a project out of nowhere) and use the same tools as for a real project. That is what we did by imagining an objective of restoration of tigers' habitats and populations (see the part **II in this Chapter**). This objective of restoration embodies a fictional project and decisions that first appeared unrelated (creation of the Natural Reserve, building of a railway, government support for livestock husbandry, etc.) can now be linked to this project and appear like different stages in the project's negotiation.

a. Identify the agents

The SEMA approach further helps us organize the agents into three groups (see **Chap 2 II. B** for more details) with their divergent roles - **actor of changes in favour of biodiversity**, **actors whose activities can damage biodiversity** and **actors that have the authority or a mediation role to confirm a new balance of power struck by the two other agents** - in the conflict about the environmental issue. This identification is a preliminary step we cannot avoid and in our case, we have to focus on the sector-based actors, that are the agents who threaten biodiversity.

To identify the role of agents regarding our environmental concern, which is broadly tigers survival, we further need to:

1. **define minimal living conditions** for tigers (habitat, health, security)
2. identify the factors that determine these conditions and their trends
3. link the factors to human threats and positive effects

So we basically need to study the ecological system to understand how tigers can be impacted by human actions and we need to link it with our study of agents' behaviours.

b. Analyse the industry sectors and channels

One of the aim of our work was also to shed light on how the organisation of industry sectors (such as the cattle industry that extend from farmers to retail outlets through intermediaries such as firms that stall-feed cattle to make it fatter or wholesalers) affects biodiversity. How products circulate through the supply chain channels ? What are the rules ? What requirements downstream agents impose to upstream agents ? All these questions are critical in the SEMA framework as it assumes economic sectors are not composed of nuclear agents that do not interact but at the opposite are organized webs of agents that can strategically coordinate and react together.

Unfortunately, our field conditions prevented us from gathering data about industry sectors and channels. Future studies that conduct works similar to ours should pay close attention to these issues.

c. Understand the rationality and interests of the agents

Here, a lot of accountancy data (prices, costs, fine amounts, quantity produced or harvested, subsidies, taxes, etc.) need to be collected to feed an *analytical accountancy* that will shade light on the gains and losses (and therefore in their *interests*) of agents in different situations. To further understand their *rationality*, considered here as how they make choice, we also need to study their environment and their social background to see what are the limitations and opportunities linked to their activities.

d. Study the decision processes

To understand the decision process, Mermet (2003) offers to follow the **money flux** and identify the **interests** linked to decisions. We also need to identify **who takes the decisions**. There are different categories of agents relative to the decision process that we can distinguish through three questions: do they pay or provide money or not ? Do they benefit or not from the decision ? Do they take part in the decision or not ? All combinations are possible such as an agent that pays but do not benefit or take part in the decision, that can be for instance the case of the European Union in the case of mountain roads to exploit forests.

The result should be drawings of:

- the money flux
- a decision tree
- the articulation between the two

We mentioned that we did not study a project but a species: the Amur Tiger. It means it was not as straightforward to find relevant decisions (in the case of a project, the decision is: do we conduct

the project or not ?) but we were still able to find different decisions we could analyse, among them: should the tigers be protected ? Should we create a National Reserve ? Should farmers be compensated for their loss to tigers ? However, these decisions would have needed much more time than available to analyse and it is also very difficult to get data about them in China's context, especially in an area close to the borders of North Korea and Russia such as Hunchun city. Some data are more or less considered as State secrets (such as compensation amounts) and the National Reserve is for some parts in the border area managed by the army. In the end, our analysis of the decision processes is limited.

2. How to concretely collect data on the field

As we noted earlier, the researcher can hardly pretend to be neutral and produce a comprehensive, unbiased analysis. It is more realist and rigorous to assume and explicit biases in the research and we accordingly recognize our analysis places **a particular environment problem as the main issue** and is produced to support agents that try to solve this environmental issue. But we also noted that this stance is problematic as many useful data are detained by agents that have no interest in the resolution of the environmental problem. **If these agents know the researcher's position, then they have no interest in collaborating with him.** That is why Taravella decided to hide his real motivations during his field work in the pioneer front in the Amazonian forest (and also because of justified fear for his own safety in this dangerous area). He pretended to study the history of the colonisation of the pioneer front as a student in agronomy, history and geography whereas he was interested in the dynamics of deforestation (Taravella 2008). It means he never directly mentioned the fate of the forest but always dealt with it through other topics. Small farmers and especially big (more or less illegal) owners were not fully dupe but they still accepted him and he was able to collect extremely valuable data. Such an approach is not without risk for the researcher which may, as Taravella did, forget his initial beliefs and start to think as the people he is studying. Moreover, is it ethically justified ? Taravella quickly sweeps this concern at the end of his Ph.D. thesis without really answering.

I wanted to inspire myself from this approach and contact people in Hunchun's surrounding villages by introducing myself as an economics students wanting either to help local development and so studying economic activities in order to produce recommendations for local governments, or as studying a Chinese major policy, the Natural Forest Protection Program, but that second option would have needed to collaborate with a Chinese scholar to render my cover more credible. As I failed to convince such a scholar to collaborate with me, I switched toward the first option. However, the NGO I had contacted first and who mentioned to me about the Amur Tiger, the Wildlife Conservation Society (WCS), explained it would be very hard to reach officials, especially in this border area, if I went there alone. As I needed to get data from officials, adaptation of the research method was necessary and I agreed to work with them and for them, at least at the beginning. Unfortunately, working with them meant being later identified as one of their volunteers (ie being considered as a defender of biodiversity) by some major stakeholders, which is exactly what I was trying to avoid. This situation also resulted from my failure to find a solid justification of my presence in the region. Because, as in the Amazonian pioneer front, the context close to the border is very specific and people there are fully aware of that (Taravella, *op. cit.*) and will not accept your presence if you do not have such a solid justification. I also failed to realize the specificity of this context and underestimated the issues with my liberty to move that would result from it.

In the end, I advice researchers confronted to a similar situation as mine to carefully identify the stakeholders and assess how they can help the research and only after this assessment decide to

partner with one or the other. Lying by omission or by slightly twisting reality may be the best thing to do to collect useful and reliable data, otherwise stakeholders knowing you are their opponent will give you bad quality data. In any way, it is deeply necessary to go on the field, in the villages, and be directly in contact with agents and do not trust data given by other stakeholders.

C. Advocacy by scientists

Is advocacy justified ? desirable ? Do scientists lose their credibility if they advocate ? We already partly answered these questions but it is worth developing them in more length as one of the main question of our Master thesis, **the possibility and desirability of a reversal of the burden of the proof in debates about the protection of biodiversity**, has clearly **advocacy** components. Why ? First because it implies **normative values**: biodiversity has an intrinsic value which it does not always need to justify and destroying biodiversity is intrinsically harmful for society (even though we do not suggest this may not be compensated by benefits to society generated by the activities destroying biodiversity). Second because the answer to this **question** is relevant precisely for advocacy (in favour of biodiversity).

We will not hide that we believe advocacy by scientists is justified and desirable but it has to stay within certain limits if scientists want to keep their credibility but above all do not fall into the pitfalls of fully subjective opinions not backed by evidences.

“As Aristotle recognized, equal or objective treatment does not mean treating everyone and every position the same, but treating equals the same. If scientists fail to be advocates and if they treat positions of different merit the same, they practice bias.”

Shrader-Frechette (1996)

To answer the questions above, we reviewed what literature had to say about it. We mainly based ourselves on the reflection of conservation biologists as not much was found about advocacy from the economic literature.

1. The possible roles of scientists

Lach et al. (2003) distinguish five possible roles for scientists:

1. **report** scientific results that other use in decisions regarding natural resources management issues
2. **report** then **interpret** these results for the same people
3. work closely with managers to **integrate** the scientific results in the management decisions
4. **advocate** actively for some specific and preferred management decisions
5. **make decisions** about management and policy of natural resources

The first role is the traditional vision of science and we further describe it *infra* when we deal with arguments against advocacy. The second and third roles are described as “*emerging as an integrative role for research scientists*” (*ibid.*).

Lach et al. conducted interviews with groups of people relevant to the problematic of the role of scientists regarding advocacy: “(1) *scientists at university and federal agencies*, (2) *managers of state and federal natural resource program*, (3) *members of public interest groups and organizations (eg environmental groups and industry associations)*, (4) *the attentive public*” (*ibid.*).

The attentive public is roughly citizen that are or feel concerned by natural resources management. They then designed surveys they sent to samples of these groups, in the end they had 639 usable answers. We briefly sum up the results about what groups considered as an appropriate role for scientists (they could agree, be neutral or disagree with each possible role): all the groups bar the scientist “prefer” (ie are more numerous to agree with) the third role. Scientists “prefer” the second role. All but the interest groups are against the fourth and fifth role. Interest groups are between neutral and agreeing with the fourth role.

It appears that even though we may have moved from the traditional vision of science - as purely objective and creating knowledge then letting others chose to use it or not and how to use it (the first role) -, in this study at least, society, except interest groups., does not seem ready for advocacy by scientists (the fourth role). It is interesting as we expect interest groups to use our results.

2. The potential pitfalls of advocacy: values, policies and trade-offs

The two following sections dealing with the risks and the desired behaviour regarding advocacy, are greatly inspired from Chan (2008) (we do not always repeat the reference to make the text lighter but it must be clear almost all the idea comes from this reference). A preference for a *value* (eg the value of biodiversity) does not imply a *policy* preference because policy involves *trade-offs* between values (such as human well-being, justice, human right, sovereignty, equity, human autonomy).

a. Biased science

"Our values may influence the rigour of our science" (Chan 2008, p.1) but the scientific process - *"documenting our methods and assumptions and subjecting them to peer review and open discussion"* -, though imperfect, should protect us from biased science. Advocates must avoid biased science because it is not a morally appropriate conduct and it has long term detrimental effects (though it may have short term positive effects for conservation) by degrading the collective scientific credibility.

b. Mixing facts and values

By mixing *facts* (*"sought through science"*, *ibid.* p.1) and *values* (*"derived through morals"*, *ibid.* p.1), we can suggest that science dictates policy choices. For example, because a species is about to be extinct, a conservation policy should be implemented to save it. However, trade-offs exist between values and so facts alone cannot decide what policy should be adopted.

c. Dogmatism

Holding one value as a *"protected value"* (Baron & Spranca 2005 quoted in Chan), that is to say one that cannot be traded off with other values, is a dangerous *dogmatism*. If one says an endangered species should be protected whatever the costs, the infringement on human rights, etc... then he is dogmatic and his crusade for biodiversity will alienate potential allies and the public in general. It is thus both inappropriate (because it can involve *biased science* and *mixing values and facts*) and detrimental to long term efficiency.

We can note that economic activities that threaten biodiversity may be dogmatic too. Their *protected value* may be human well-being or economic profits and they may not be ready to trade it off with biodiversity. This kind of *dogmatism* must also be opposed and that is also the role of

scientist to point it out and advocate against it.

d. Hidden agenda

Professing objectivity and not acknowledging its own interests and values when arguing for something will let other stakeholders speculate about our *hidden agendas*, which also degrades scientific credibility.

3. How scientists should behave themselves regarding advocacy

The article we inspired ourselves from (Chan, *op. cit.*) was dealing with how conservation biologists should behave themselves. But its advice can be extended to any scientist and we tried to generalize them as much as possible.

a. Advocacy for policies

Scientists should explicit the different options and the difference in merit between them if this difference stems from science (eg different estimated probabilities of extinction). This is technical interpretation though, not advocacy for what trade-offs to make.

The trade-offs between values necessary to choose a policy must be chosen by society with scientists having only one voice to cast their choice, as other citizens. The weights given to each value are thus "*outside the bounds of science*" (Noss 2007) and should result from society's choices.

It means that scientists or professional societies should stay clear of advocacy for policy or practise it as any other citizen, without abusing "*the public goodwill toward science*" (Chan, *op. cit.*). It also means it must be clear "*where science ends and where personal and institutional values and value rankings begin*" (*ibid.*).

b. Value neutral language

Unlike Lackey (2007) who argues for value neutral language (*infra*), Chan believes we always have "*preference for population and ecosystem states*" (Chan, *op. cit.* p.2) and as a consequence, "*there will always be conflicts of interests*" (*ibid.*). It means "*We are forced to choose between stated conflict of interest (value-laden language, risking the mixing of facts and values) and unstated conflicts of interest (a hidden agenda)*" (*ibid.*). Chan believes the first option is the best one. And he suggests ways to minimize the mixing of facts and values such as justifying - with facts and values that we explicitly state - the baseline against which we evaluate the state of the ecosystem. We also need to justify both our language and our values.

c. Advocacy for values

Chan believes **we should advocate for values and justify our advocacy**. As "*knowledge of biodiversity does not seem to increase concern for it*" (Chan 2008; Hunter & Rinner 2004 cited in Chan 2008), it is necessary to advocate and not just inform. However, because we know other values are important and to avoid that people (wrongly) perceive bias and fanaticism, the importance of these other values can be acknowledged (for our concern, they are values other than biodiversity, for instance equity, human autonomy...). Advocating for one value must not at the same time be advocacy against all other values.

To efficiently advocate for values, Chan thinks scientist have to be interdisciplinary individuals

(and not only in interdisciplinary fields), they have to be able to argue on an ethical standpoint why their advocacy is justified.

d. Advocacy for advocacy

Scientists and scientific institutions have to advocate and **promote advocacy by scientists**. There are many hurdles to advocacy (little time for public education or policy engagement in academic jobs; lack of skills and methods for public communication and policy intervention; fear of a loss of credibility) but **to obtain the cultural and institutional changes necessary to protect the values they believe in**, scientists have to advocate (especially in the case of biodiversity's value, whom non-human beings cannot themselves advocate for).

Some social sciences' authors also argue that advocacy by scientists is necessary. Bruno Latour offers a model to understand how society take into account problems such as environmental issues (Latour 1999). What society and what takes into account constitutes a *collective*. So by definition, all non-humans that are outside the *collective* are not taken into account by society. That can for instance be the case of the beetle we mentioned in introduction. In order to introduce a new entity such as the beetle inside the *collective*, it is necessary to go through four steps: **perplexity, consultation, prioritization and institution**. Scientists can alert the collective about entities that do not belong to it yet, which will launch a perplexity phase during which the collective will wonder if there is indeed such an entity or not (eg climate change). Then scientists can argue for the entity's admission during the consultation phase when the collective wonders whether it should or not consider this new entity for admission. Latour (*ibid.*) thus generalize the process of inclusion inside what society takes into account and applies it to all non-human entities. Interestingly, for Latour, **all entities outside the *collective* cannot advocate for themselves** (the collective is not even aware of their existence and so cannot hear them) so **someone inside the collective needs to advocate for them**. That role can be carried on by scientists.

4. Arguments in favour of advocacy

Proponent of advocacy by scientists do not mean we should all become eco-warriors and block trains moving nuclear waste from one place to the other. What to avoid ?

“Personal bias will determine to a great extent what we choose to study, how we interpret the results, and to what extent we advocate particular policies or actions. If we allow our biases to get control of us, to the extent that we seek out data to support preconceived conclusions, selectively cite literature that agrees with our conclusions, ignore conflicting evidence, become dogmatic in our opinions and preferences, or—worst of all—fabricate or alter data to support our case, then we have gone too far, and we deserve every bit of scorn and distrust our scientific colleagues and society at large may heap on us.”

(Noss 2007)

Advocacy should be considered good for science so as long as **(1)** we respect and promote the “values of science”: information needs to be gathered in a rational, systematic, testable, and reproducible manner. It means among other things we have to test our assumptions and be ready to ditch them if they prove wrong, not to occult results or works that are against our conclusions and never alter data. And **(2)** we clearly express what we are advocating for. Noss gives several reasons why:

1. Because **we are biased** by our own emotions and values, our preferences and experiences and it influences what we choose to study, the way we analyse results and "*to what extent we advocate particular policies or actions.*" (*ibid.*). It is thus better to recognize it and advocate explicitly.
2. Because **science is a social construction based on values**, one of which is objectivity (but objectivity itself "*relies on the subjective judgements of fallible human beings and social institutions to detect and correct errors made by other fallible humans and institutions*" (Stern (2005: 977) quoted in Noss 2007).
3. Because (1) **policy makers may not sufficiently understand science** to make a rational choice and (2) **they may not be altruistic and honest** and thus may not behave in the best interest of the public. The best policy choice must therefore be clearly advocated for by scientists, in regard to their knowledge and studies.
4. Because of **the intrinsic values of non-human beings** and the fact that they cannot speak for themselves so conservation biologists have to advocate for their protection. This reason also stands for all entities that are not taken into account by society and the *collective*, not only for biodiversity (*Latour 1999*).

Another powerful argument is that **a scientist cannot stand above the fray and observe the situation from outside** to provide an objective vision. He is part of the system, is influenced by it (for instance through his funding) and influences it by the uses stakeholders can make of his results. It is thus more productive to acknowledge one's bias and clearly work with a specific goal and with a specific lighting of the problem than to pretend to be objective and to produce data and analysis equally useful to all. But such a posture can yield satisfying results only if all the sides are represented by research teams and their methodology and results are discussed in a pluralistic debate (Mermet 2011).

5. Arguments against advocacy

Lackey (2007) argues against advocacy in science because he believes science must deal with the facts ("is") while politics must deal with the preferences ("ought"). His arguments are:

1. if one at the same time attempt to be "*both the provider of policy neutral science and an advocate for one's personal policy preferences*" (*ibid.*), there are conflict of interests and it can even be unethical if not clearly communicated.
2. debates about environmental issues are bitterly fought ones and sometimes very controversial. There are sometimes doubts about a "hidden agenda" from scientists who would not promote the best solutions for society but only what they believe or what is the best for their interests. Scientists who advocate for their preferred policy put at risk the credibility of the whole scientific community and encourage scepticism about scientists' position and confusion in the debates.

However, Lackey agrees that science is a social construct and so reflects the values of its participants, scientists. But he contradictorily has discomfort "*with science influenced by policy preferences*" (*ibid.*). So he argues in favour of an use of policy neutral vocabulary, for instance we should not talk about the desired state of an ecosystem or if it is in "good" or "bad" condition because it implies policy preference, instead, we should talk of "increase", "decrease", "changes"...

In his conclusion, Lackey (*op. cit.*) invites scientists who, despite his warnings, want to advocate to clearly express they leave their role of scientists when they advocate and enters a *policy advocate* role. He also invites them to remind that in a democracy, their voice does not have more weight than

any other person.

Interestingly, Lackey's arguments can both apply to scientists that advocate for the environment and to scientists that work for the very economic activities that threaten the environment. Those latter sometimes seem animated by a dogmatism that, if they work in agribusiness for instance, put higher yields and the mastery of fields' environment above everything else, flirting dangerously with biased science.

6. Consequences for our work

Our work strongly resonates with these arguments for and against advocacy in science, even more as these articles (Chan 2008; Lach et al. 2003; Lackey 2007; Noss 2007; Shrader-Frechette 1996) were written about conservation biology. As environmental economics scientist, we study the possibility of a form of advocacy for biodiversity. Are we justified to advocate for biodiversity ? We follow Chan (2008) and answer that yes we are because we believe in this value and if we wish to protect it, we face no choice but to advocate. Is there a risk of losing our credibility as scientist or of being non-ethical ? Yes, such a risk exists but if we pay attention to the issues of *biased science*, *mixing facts and values*, *dogmatism* and *hidden agendas*, then we can minimize these risks.

Chan recommends to justify and explicit the baseline against which we judge the situation and accordingly use words such as “healthy”, “bad”, “good”, etc., to qualify the ecosystem or the species of our concerns. We heed this advice and follow it in our next section. So we do not use *value neutral* words and at the opposite qualify some activities of being *incompatible*, *compatible* or *synergistic* but it is clearly in reference to our *reference objective* (defined *infra*) and we clearly state the same activity can have a different status with another *reference objective*.

Is our work biased science ? We recognize we focused more on literature that share some of our ideas and accordingly cite it more often but this is not to purposely smother dissenting arguments. We are ready to change our assumptions and conclusions if confronted with contradictory evidence. For instance, we first assumed compensation could be a *perverse incentive* that would cause great harm to tigers because this public policy is implemented without paying attention to the consequences on the incentives it sends to farmers (see **chap. 2, IV. J. Influence of perverse incentives/subsidies on the drivers**). However, evidence show its effects are limited and though it is a *perverse incentive*, it is not likely to harm tigers, so we changed our judgement on compensation.

A stronger criticism that can be addressed to our work is *dogmatism* : we place an environmental issue at the centre of our concerns and then analyse the situation relative to this issue. Actually this criticism can be addressed to the whole SEMA approach (*supra* and Mermet 2011) which mainly (only ?) consider environmental values and not other values as the ones to protect and advocate for. The answer to this criticism is that we acknowledge the existence and importance of other values and believe other research teams should be (and are already) defending and arguing for these values. We already contended (**I. A. Theoretical framework**) that research can be partial because analysis cannot be useful for everyone. So it is necessary to have a number of research teams, all working with different perspectives and values and advocating for them, so that the society can then choose which values it considers are the most important.

We do not have *hidden agenda* as we clearly express we want our work to be used by agents protecting biodiversity.

So this discussion highlights and strengthens the importance for our work to clearly define the *reference objective* we judge the situation against, to clearly define the terms and to justify them as

well as to express and justify what we are advocating for.

Through our work, we hope to let the *collective* defined by Latour to include tigers in its membership. The author highlights how economics allows to describe what society already takes into account and what it considers as external (and thus does not seek to protect). Economics has an auto-reflexivity power that lets society sees itself. Why does it possess this power ? Because of its work of "*documentation, d'instrumentalisation, de formatage que les comptables, statisticiens, économètres, théoriciens pratiquent jour après jour*" (Latour 1999, p.206) which can be translated as a work of "documentation, instrumentalisation, formatting that accountants, statisticians, econometricians, theorists practice day after day". Economists collect data about society and analyse them, delimiting the borders of what is inside and what is outside the *collective*. Similarly to the TEEB (2010), Latour (1999) believes economics is a common language shared by all and that it allows it to describe the *collective* in a language understandable by all. We do not agree and believe many values held by society cannot be translated in economic language, but it can still allow to describe quite accurately what is inside and what is outside the collective. However, economics does not allow to discuss what is taken into account and what is outside society's conscience. So other sciences are needed, especially to define the causality chains, alongside politics and moral (Latour 1999, p.208).

II. Our reference objective: restoration of tigers' habitats and populations

The theoretical frameworks we mobilise lead us to define a *reference* against which we will analyse the current, *de facto*, situation. It allows to observe where gaps between the two situations exist and analyse the origins of these gaps.

A. Choice of the reference objective

Our object of concern are worldwide Amur Tiger populations. They are currently distributed only in Russia and China, the majority of them (about 331-393) are in Russia Far-East while China would host only 16-22 tigers (D. G. Miquelle et al. 2010). We can add that Amur Tigers can currently only be found in two north-east Chinese provinces: Jilin (吉林) and Heilongjiang (黑龙江). But according to the IUCN red list, in the past, its range extended further into China, in North Korea and even stretched to Mongolia (*ibid.*). Other sources claim that the Caspian Tiger belongs to the same subspecies as the Amur Tiger (Driscoll et al. 2009 quoted in Wikipedia 2011), so the range of the Amur Tiger could even be extended to the historic range of the (extinct) Caspian Tiger, which extended as far as Georgia (Ognev 1935 quoted in Wikipedia 2011).

The objective we choose for future tiger populations and habitats is based on the IUCN red list claimed historic range, it thus consists in a come back to the situation that existed years ago (we were not able to find when but it is likely to be at least in 1900 or before). Population objective is a self-sustainable population all over its range. So our *reference objective* can be expressed as :

A self-sustainable population of Amur Tigers reconquering its original historic range ie ranging from Russia Far East to North Korea in the south and Mongolia in the west.

Why do we chose such a *reference objective* ? Another possibility would have been the conservation of Amur Tigers in their current restricted range. These two references may be both

justifiable. However, from an ethical standpoint, it seems more appropriate to restore the historical range of tigers since it is human action which pushed it out of this range and close to extinction in the first place. This aim can be considered reasonable, as long as costs to achieve it are not disproportionate. It is also what most of the actors in the environment protection field we met expressed as their long-term objective. As we want to produce operational results that are usable by field workers, it makes sense to choose a *reference objective* they seek to achieve. Actually, a first step towards this *reference* was documented (WWF et al. 2010): it identified 38,500 km² of areas in Jilin and Heilongjiang province suitable for tigers.

B. Sustainability conditions for tigers

Our *reference objective* mentions a "self sustainable population" but what does it mean ? What conditions need to be met to reach a self sustainable tiger population ?

A *self sustainable population* is a population that manages to reproduce itself fast enough to compensate for natural deaths and human-caused deaths. Sub populations of tigers also needs to be connected with each other otherwise the genetic diversity may be too low (D. G. Miquelle et al. 2010) and translates into lower survival chances (for instance because of congenital malformations caused by genetic issues). This second condition means habitats have to be connected with each other.

Tigers live in forests and hills in boreal and temperate climate. The factor that influences the most their distribution is the presence of their preys (mainly deer and wild boars) and as a consequence the distribution of mixed coniferous-deciduous broad-leaf forests, especially Korean pines. Riverine forests are preferred to other types of habitats but remain rare in the home range of Amur Tiger (D. Miquelle et al. 1999). They need quite huge home range : *"resident female tigers need 250-450 km² to successfully rear cubs. Males' territory can be up to 2000 km² and overlap with several female territories"* (WCS Russia n.d.). To maintain populations of tigers, vast swathes of forests with abundant deer and wild boars are therefore needed. Such forests exist in China, Russia and maybe North Korea but connections between them may have been cut and replaced by agricultural lands. Furthermore, the preys abundance may not be sufficient because of legal and illegal hunting of preys and human disturbance inside forests.

We describe the drivers threatening the tigers in **Chap. 2** but we can briefly list the drivers that need to be in most cases eliminated (and in some cases a reduction of their intensity may be enough) if sustainability conditions have to be met (and refer our readers to **Chap. 2** for additional details). We classify them according to their effects :

Table 2- Brief list of the incompatible drivers and how they threaten tigers

Drivers	Reduce habitat	Indirectly increase mortality of tigers	Directly increase mortality of tigers
Cattle husbandry	x	x	
Poaching of tigers' preys		x	x
Poaching of tigers			x
Crop production	x		
Frog breeding		x	
Non Forest Timber Product collection		x	

Indirect increase of mortality happens through (1) perturbation of tigers when they could eat a prey they killed, reducing the amount of their meat intake (Kerley et al. 2002) or/and (2) decrease of preys populations which reduce the number of available preys for tigers (WCS Russia n.d.). *Direct increase of mortality* means tigers are killed (poaching of tiger's preys can kill tigers who accidentally get caught in the biggest snares; it is rare).

There was no quantified estimation of the relative importance of each threat in China because radio collared emitters are not used to track tigers and understand how they live (and die). Russia does use such devices so some estimations are available but they are based only in a few observations and may not be fully representative. In addition, Russia and China are very different with much more tigers living in Russia which allows poaching to develop (we will deal with this topic later in **Chap. 2**). Beyond quantification, there is a consensus from tiger experts (such as Dale Miquelle, Tang Jirong, John M. Goodrich) that the drivers listed in the table above are indeed threats for tigers that need to be fought (WCS Russia n.d.; Kerley et al. 2002; B. Li et al. 2009; Nowell & Xu 2007; 郎建民 2010; D. G. Miquelle et al. 2010).

C. Restoration conditions for tigers

To reach our *reference objective*, sustainability conditions must be met not only in current living area of tigers but also in as many places in their historic range as possible. These places must also be linked through corridors tigers can use to move from one patch of "restored" forest to another. In some areas, this implies agricultural fields may need to be replaced by forests and massive transport infrastructures (road or rail) must not be built, otherwise tigers migration westward would be prevented (unfortunately, such a massive transport infrastructure project is under way as we explain in **Chap.2, IV. I. Road and railway building**).

III. Case study area

A. Environment

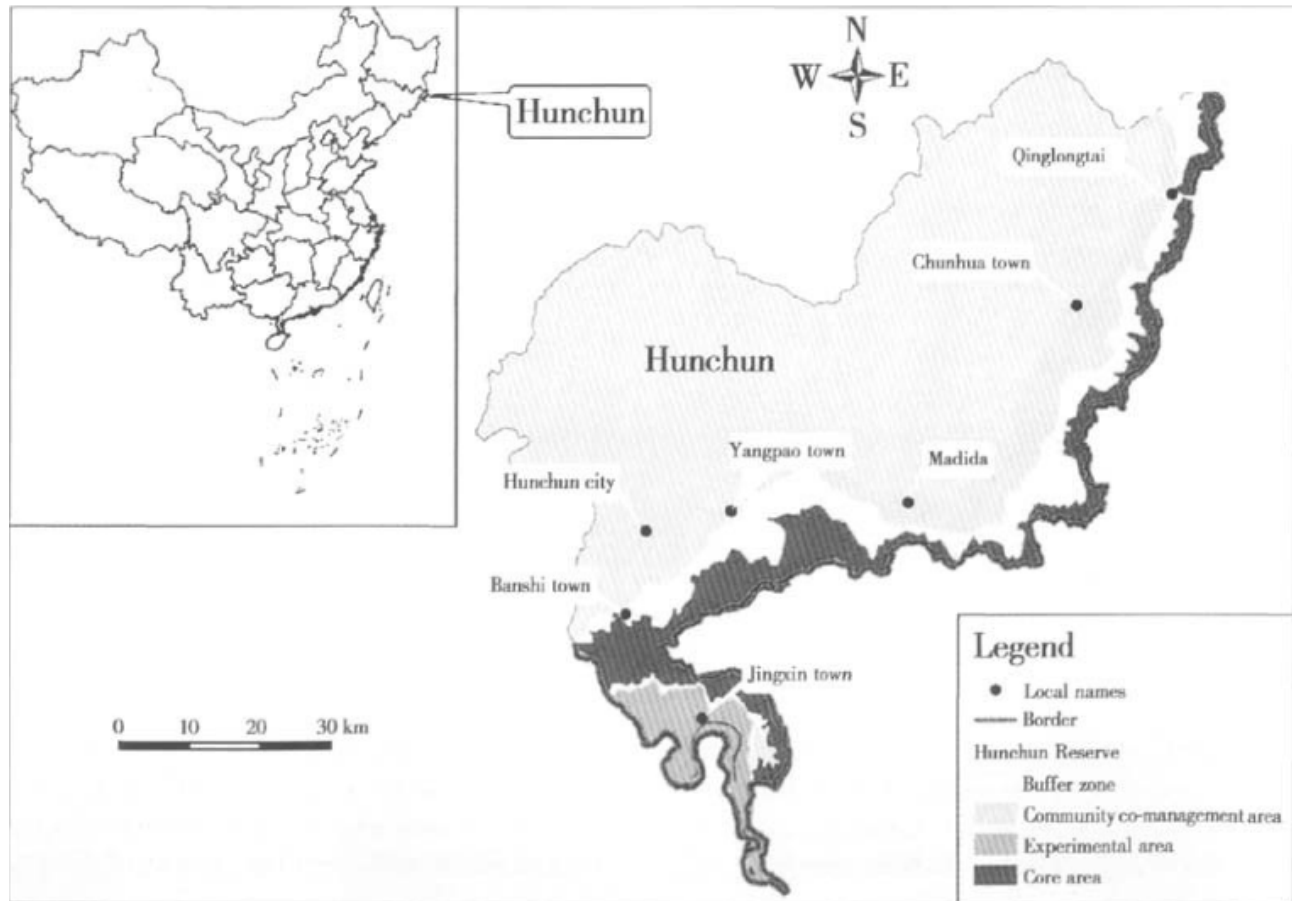


Fig. 1 The Hunchun National Nature Reserve, Jilin, China

Figure 2- Hunchun National Nature Reserve localisation. Source: B. Li et al. (2009).

Our study area is Hunchun city and its surroundings as represented in the figure above. In China, a city (市) is an administrative division above town (镇), township (乡), and village (村); it includes all these sub-unities in its area. So Hunchun city includes both the city in itself and its surroundings, for a total of 4938 km². As can be seen on the map, the National Nature Reserve of Hunchun is adjacent to the borders : North Korean in the south west and Russian in the east. It is thus quite a sensible area, especially for foreigners, and all the area at 2 km or less from the border is under military control. Research (including for what interests us such as ungulate and tiger monitoring) is *a priori* forbidden in this area and requires an authorization from Beijing's State authority. Towns and townships farther from the border may be accessed by Chinese but they are still under border police control and foreigners are not really allowed to work there either. I mainly collected data in Chunhua town, one of the northernmost town of Hunchun city and one which probably has the highest density of tigers (according to WCS's staff and compensation data that shows most tiger attacks on cattle happen in Chunhua and a township between Chunhua and Hunchun: Hadamen).

Hunchun's arable land represented only 28,322 ha in 2009 (Hunchun's Government 2009) whereas the whole Jilin province had more than 4,400,000 ha of land cultivated for cereals in 2010

(吉林省统计局 n.d.; China Knowledge.com n.d.) so Hunchun's arable land area represents only about 0.6% of the area for Jilin province. One of the major source of human-tiger conflicts (because that is where tigers kill livestock), pasture areas are even smaller. It proves that the conflict is very limited and highly local.

Jilin Hunchun National Nature Reserve (JHNNR) was created in December 2001. It is connected to three other reserves in Russia and was designed to be a key corridor for tigers and leopards moves. Monitoring of tigers in the JHNNR is very difficult but there would be between 3 and 7 tigers living or visiting the reserve every year (B. Li et al. 2009). They would be part of a sub-population of tigers living in Russia but disconnected from the main population of tigers in Russia (D. G. Miquelle et al. 2010). The JHNNR has a total area of 1,087 km² (B. Li et al. 2009). A report written conjointly by WWF, WCS and other local and international NGOs and universities assessed (a) potential habitats for tigers in Jilin and Heilongjiang province and (b) how to implement a reconquest of its habitats by tigers (it determined it could be achieved through the establishment of corridors, the extension of nature reserves which represent core areas for tiger breeding and the creation of Tiger Priority Conservation Areas that would adapt their development projects to be compatible with tigers). This report gives a very interesting figure:

“Such reserves will only be effective in conserving tigers if they are large enough to retain a minimum of 3-4 adult females, which would require 1200-1600 km²”

(WWF et al. 2010)

So according to this estimation, Hunchun Nature Reserve is too small to be effective in conserving tiger. So is the Chinese government just green washing by establishing this reserve ? The government would act as if it cared about tigers but actually allocate an insufficient area, that is in addition stuck to the borders, to create the reserve. It should be noted this zone is anyway a military zone which should not be entered, so almost no one was disturbed when the reserve was instituted. Or is it that the Reserve aims to become a corridor between several reserves in Russia and a possible way of reconquest toward North Korea (even though tigers would have to cross a river, and North Korea is not the most hospitable land for them) ? We are unable to answer the question and the debate stays open.

B. History and law

As soon as 1988, China promulgated a **Law on the Protection of Wildlife** that stated clearly that **(1)** people harming wildlife should be punished (we will deal with the concrete punishment in **Chapter 2** when we consider poaching), **(2)** compensation should be awarded for damages caused by wildlife (which logically follows from the legal status of wildlife as property of the State, unlike in many European countries [De Klemm 1996]) and **(3)** reserve should be created where wildlife under special State or local protection live and breed (Seventh National People's Congress of the People's Republic of China 1988). This last element is probably the reason why the Hunchun Nature Reserve was eventually created in 2001.

In 1993, China promulgated a **Decree Banning Trade in Rhinoceros Horn and Tiger Bone** (D. G. Miquelle et al. 2001).

In 1996, Jilin Province took a step further (that Heilongjiang province did not take) and banned hunting of all wild animals for five years (D. G. Miquelle et al. 2001). It is still banned to hunt wildlife now. Guns are also prohibited and 104,000 had been confiscated between 1996 and 2000

(*ibid.*).

Cutting forest is also very controlled. At the national level, China has a strong afforestation policy and is the country which increased the most its forest area in recent years (against a global deforestation trend actually). At the local level, it translates into a State company, the Hunchun Forest Bureau (珲春林业局) which is the only firm allowed to manage forests for a commercial purpose. Villagers are forbidden from exploiting the forest though they may cut small quantity of wood for heating purposes for instance (Jirong Tang, pers. com. 2011).

We can resume these actions as efforts to stop two great threats to tigers : (1) poaching and an underlying reason for poaching : Chinese medicine use of tiger parts. And (2) deforestation and the associated habitat degradation and fragmentation. We will see in Chapter 2 if the associated drivers really disappeared.

C. Stakeholders

We briefly describe the main stakeholders here.

The **Wildlife Conservation Society (WCS)** is an international NGO that aims to protect wildlife all over the world. It was founded in the USA. Compared to other such NGOs, it claims to focus on science-based evidence to solve conservation issues and it does more field than communication work. It has an office in Hunchun with four people in normal time: a manager, and three employees with each a main task: administrative work and driving; species survey (tigers and ungulates); and community work (education, incentive programs). **The aim of WCS in Hunchun is clearly to protect the tigers.** They do so by (1) providing reliable information about tiger and prey situation and (2) trying to reduce major threats to tiger by removing snares, patrolling and trying to change attitudes (Lynam & Xie 2008). We will discuss for instance an economic incentive change program they designed for bee keeping, in **Chapter 4**.

RARE is an international program and lead a “Pride campaign” which aimed at promoting wildlife conservation through positive feelings about wildlife. In Hunchun, the head of the education and propaganda department of the Nature Reserve, Lang Jianmin (郎建民), participated in a Pride campaign. He identified the threats to tigers (and found the same as us, but also additional threats that we did not consider such as possibility of fire), linked them to human activities and then designed a plan to change some of the behaviours that result in threats to tigers (郎建民 2010). He chose an aim that was reachable : reduce poaching. To achieve it, he tried to educate people all along the human chain that is involved in poaching : the poachers, the restaurants that buy and sell game meat, the officials who used to accept wild meat as presents and the ordinary consumers. It did not consider economic incentives because it judged them inappropriate and also hard to modify (for instance fines are defined by the State law and cannot be changed easily). Instead, it relied on communication and education (through supports such as calendars, drawing, billboards...).

As we stressed, our case study area is very close to two sensitive borders : the one with Russia and the one with North Korea. Border guards thus play key roles in the region. They are divided in several groups and we do not fully understand their complex structure but we can draw a basic distinction between the **border police** and the **border army**. Border police is ubiquitous in all the villages of Hunchun area and they are of course especially present close to the border. They control all activities and border police guards for instance register every person who spend the night in hotels in villages. This is a particular problem for foreigners like me who plans to spend time in

villages to interview farmers. But it is actually a problem for any organisation that wants to protect the tigers by monitoring their population, implementing schemes in village, etc. This hindrance adds up with hurdles from other stakeholders such as the Reserve and the local governments. But actually, if one is authorised and supported by these two stakeholders, border police may let him alone (that is what happened with me and WCS in the end).

The **border army** is less of a problem. They keep swathes of land that extend from the border to 2 km away from the border inside China. They do not seem to care much about activities pursued close to the border, unlike the border police.

The **Nature Reserve** is under the authority of the government and its staff are government's employees. Conflict of powers can happen with WCS or other NGOs because the reserve and its head of department have their own interests and programs in villages. So the Reserve may prevent WCS from going into some villages where it itself runs programs. The Reserve is supposed to organize patrol inside the forest. It seems its rangers do not have authority to arrest or even fine poachers they may encounter ; they are not very well trained and geared. Human activities are legally prohibited inside the core zone (State legislation) **but local authorities allow farmers to let their cattle pasture inside cleared areas inside the forest** (we call these meadows *forest pastures* in the rest of the report). All kind of human activities occur inside the Reserve.

We already mentioned **Hunchun Forest Bureau** (珲春林业局). It is a State company that exploits the forest. It has thousands of employees and is supposed to sustainably manage the forest. The Nature Reserve is actually part of this Hunchun Forest Bureau.

Without entering into details, other relevant stakeholders are:

- **a local NGO** protecting the tiger that collaborates with WCS in one village
- **WWF** which is another international NGOs and another player in the power game that occurs around Hunchun's villages (it means some villages are “controlled” by WCS, other by the Reserve, other by WWF ; all want to be the first to shot a picture of wild tigers)
- **the municipal (Hunchun) government** seems to have a role of transmitting villages' projects to the higher levels of hierarchy (province and then State) and it pays the compensation for wildlife damages to the villagers
- **villagers** themselves. We will describe their activities in **Chapter 2**
- **village's heads and heads of the communist party** who are elected by villagers and manage village money (non negligible sums can come from the State) and have very key roles in the village's decisions and common strategy (eg to engage together in stall-feeding or not)
- the **national government** which determines a part of the wildlife-related legislation (see **B** above) and provide money to villages for projects such as stall-feeding
- the **provincial government** which also have a say in wildlife-related legislation (see **B** also) and is supposed to provide 50% of the money for compensation.

Chapter 2- Logics of the drivers

I. Definition of driver

Drivers are groups of people or industry sectors that have an effect on the Tiger and that are moved (driven), by a common set of *incentives* and/or *intentions*. In an OECD report, Bagnoli (2003) defines *incentive* as "*measures that make use of the price system and market forces to achieve their objectives*". This definition should be the definition of *economic incentive*. Social and cultural incentives also exist and drive economic agents to exhibit a socially acceptable or appreciated behaviour or to choose culturally accepted ways of productions (eg traditional husbandry which means to let cows graze in pastures in the forest as it has been the case for years). *Incentives* can also be understood here in a broad sense and include the way institutional structures influence *drivers*.

Drivers could also be seen as **forces** that drive changes such as deforestation, habitat conversation, etc. (TEEB 2010). We do not use this definition as it occults the intention behind the changes. Deforestation is not a blind process, it is the result of actions by people and when deforestation is opposed, these people will adapt and resist.

II. Typology of drivers and incentives

As stated in the introduction, we use the Strategic Environmental Management Analysis (SEMA) (Mermet 2011) as a framework of our analysis. The reference we take and against which we will assess the situation is the return of the tiger to its original range and population. In the past, tigers were found from Russia to north east Mongolia and in the Korean Peninsula (WCS Russia n.d.).

A. Intentional and actual management

In the SEMA framework, we distinguish these two types of management. Drivers can intentionally try to change tiger situation, they then *intentionally manage* the system. How people really act (and not always what they say) constitutes the *effective management*.

B. The three types of drivers: strategic environmental, sector-based and regulators

In the Strategic Environmental Management Analysis (Mermet 2011), three types of actors are distinguished:

- the *strategic environmental actor* promotes changes in favour of the environment and faces resistance.
- the *sector-based actor* belongs to the activity **sector** which is destroying or threatening biodiversity. Three types of answer to the strategic environmental actor's actions can occur: **(1)** resistance to the change and action against environmental demands; **(2)** integration of the environmental concerns; or **(3)** "*promote a redefinition of environmental concerns and strive to reorient environmental action*" (Mermet 2011).
- the *regulating actor* serves as an **arbitrator** who entrenches the new equilibrium of

power reached by the two other actors strategic struggle. So unlike in many conceptions of environmental management, the definition of the *regulating actor* by SEMA means this actor do not take the initiative to pass regulations to protect the environment. But such regulations could actually be the results of efforts by *environmental actors* inside the regulating body.

Generally, *sector-based actors* can also be called *adversaries* (of biodiversity) as their activities threaten the tiger. *strategic environmental actors* are *advocates* (in favour of biodiversity) or *protectors* (of biodiversity) because they try to protect the tigers.

By distinguishing the adversaries, the advocates, those who have an intentional and those who have an effective management, we can have a clearer vision. We acknowledge it is partial, as another reference would give another vision, but we believe this standpoint is useful for the protectors of the tiger.

C. Need to change the drivers and potential to do so

In order to evaluate the potential to modify the drivers and reach a better outcome for the tiger, we will introduce some classifications that can be applied to the drivers and we will then discuss how we can use them.

1. Economic incentive indicator

To measure the **economic incentives** faced by an activity, we selected two indicators:

- costs to carry out this activity which is one measure of the difficulty to pursue it. Another measure would be the investment needed. It is also very relevant and we will discuss it in a case by case basis later. So the costs mentioned here are the **operational cost** (eg for husbandry it is the cost to feed cattle, of medicines, etc.).
- profits of this activity which form a measure of the attractiveness of the activity.

Table 3- Economic incentive indicator typology.

	Low costs	High costs
High profits	Windfall	Intensive
Low profits	Auxiliary	Breadwinner
Negative profits	Market anomaly	

We defined five categories: *windfall* are like bonanza with low costs and high profits; *intensive* activities bring high rewards but need more inputs or more expensive inputs and consequently have higher costs (so for instance, the costs would be 1000 and the turnaround 2000, meaning a 1000 profits, whereas a *windfall* activity would have costs of only 10 and turnaround of 1000 meaning about the same profits); *auxiliary* activities are not very lucrative but as they have very low costs, they can be used as an easy income source; finally *breadwinner* are activities that should not really exist as less costly or more profitable activities exist: they have high costs but still yield a little money. In the table, negative profits mean activities are losing money. If an activity really loses money, it should naturally, by the laws of the market, stop. So we should not encounter such kind of activities, that we can call *market anomaly*; but if we do encounter them, we would have to analyse it beyond our current framework. As we will show, husbandry is sometimes losing money. *Market*

anomalies and *breadwinners* must be clearly distinguished: whereas the former lose money and so should really not exist, the latter do earn a little money so it can be understood they are pursued. But if someone has the choice between *breadwinner* and any other type of activity (bar *market anomaly*), then he should naturally choose the other. We called this type of activity *breadwinner* because it is likely to be pursued because one has no other choice but to carry it out to earn his living and it is thus his only breadwinner (but we can find other examples such as organic farming or social business which indeed have high costs but are supposed to make some profits and these activities are pursued to perform duties that go beyond simple profit).

We can only judge of the degree “*low*” and “*high*” in relative terms. A cost greater than the mean cost of all activities is *high*, whereas it is *low* in the case it is less than the mean cost.

2. Opportunity cost to change to more biodiversity friendly practices

In theory, we can also define a *future activity*: either a **variation of the activity that is more “biodiversity friendly”** (eg organic farming for the activity “grow crops”) or a **substitution activity that could replace the activity of interest**, also called *current activity* (the substitution could for instance be bee keeping). Then we can define the *opportunity cost* of renouncing to the old activity of interest to do the future activity.

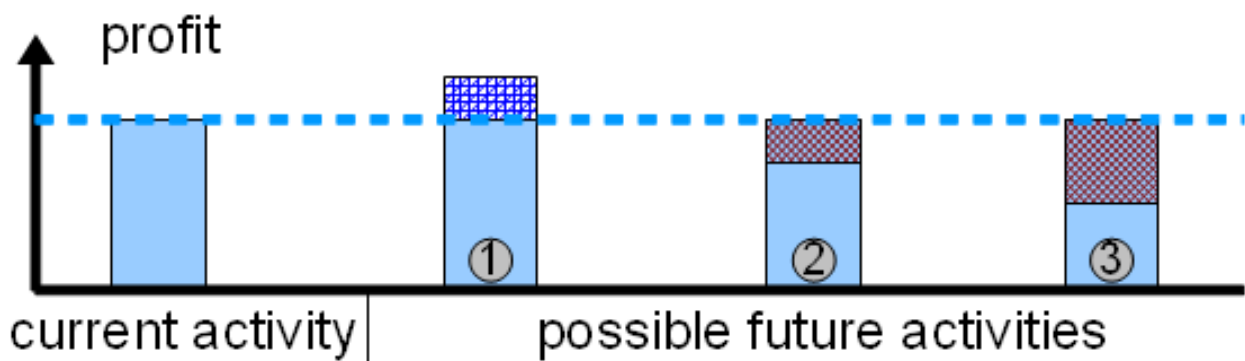


Figure 3- Opportunity costs – adapted from Laurans, Leménager, et al. (2011), citing Wunder (2005).

As illustrated in the figure, that opportunity cost can be :

- negative (1): the future activity is more profitable than the current one. It means there should be less hurdles to prompt people to switch from the current to the future activity.
- low (2): the profit of the future activity is slightly lower than the profit of the current one. As explained in Laurans, Leménager, et al. (2011), in this situation, economic tools such as payment for environmental services would in theory be ideal to use.
- high (3): the profit of the future activity is much lower than the profit of the current one. In this case, it will be costly to protect biodiversity through economic tools (or only a limited number of economic agents will be influenced which may not be sufficient to produce the desired effect) and regulatory tools will probably be necessary.

3. Indicator of the effect on tigers

Ideally, we would quantify the effect of human activities on the tiger through economic-ecologic indicators that could for instance assess the increase of the death rate of tigers associated to a unit of output for each economic activities. But such an indicator requires a lot of work to be developed and, above all, data to create it are out of reach in Hunchun. Therefore, to make our third

kind of distinction, we considered only very simple, **qualitative** categories that can be determined and used on the field. Relative to the restoration of the tiger habitat and population, activities can be:

- *compatible* (eg bee keeping): the activity can persist without threatening the tigers.
- *incompatible* (eg poaching, cattle in the forest...): the activity has a negative outcome on the tigers and they cannot both exist at the same time on a given place.
- *synergistic*: the activity has a positive effect on the tigers and can help them reproduce and gain control of an extended range.

4. Use of the typology

Our typology can be used in two ways: one as an **advocacy tool** to oppose activity sectors that threaten biodiversity and whose profits can be judged to be too low, and another as a **technical tool** to determine what kind of tools, if any, in theory appear the most appropriate to trigger a change on the sector considered.

a. Advocacy tool

As Mermet (2003) notes, costs-benefits analysis can highlight the absence of economic collective value creation of a (infrastructure) project and, if used in a context where it can trigger discussions on the importance of different values (among which the economic value), then it can help the opponents of the project to stop it because the project is not justified by any collective rationale. He underlines two different different aspects of negotiation and decision: the **total value for society** and the **distribution** between agents. Costs-benefits analysis consider only the first one, as usually do economic valuations of charismatic biodiversity and of ecosystem services. But the distribution aspect is as central or even more central in the eyes of negotiators and decision-makers: valuations determine that the sum of ecoservices is 1000€ but how much do they receive ? What is their share ? Sometimes, the total value for society is negative although the value for one agent is very high: he kind of steals benefits from society (that could be the case of a very polluting but very profitable factory). From the social welfare point of view, that is unfair and should be opposed. But what we want to investigate corresponds to another case: when even the value for the agent that benefits the most from the activity is **very low or even negative**. In this case, society doubtfully gains from such an activity, especially if it has negative impacts on biodiversity. Economic valuation of the activity's profits should give arguments to force it to stop.

Table 4- Use of the economic incentive indicator to advocate for biodiversity.

	Low costs	High costs
High profits	Windfall	Intensive
Low profits	Auxiliary	Breadwinner
Negative profits	Market anomaly	

According to the **profits** of the sector, it will be more or less easy to fight against it. The **costs** do not play a direct role here but can still be interpreted (see below).

- **negative profits**: except if they have positive externalities (but that should not be the case for the adversaries of biodiversity we are focusing on), such activities decrease the social

welfare. Advocacy against them should therefore be based on social welfare and it should be quite straightforward.

- **low profits**: the activity is still making some money so economic valuation of the adversaries of biodiversity alone is not sufficient to fully discredit the activity. But it can still be interesting to show that the profits are very low because people may not really have realized it. In theory, in order to demonstrate that the activity does not create collective profit, we need to prove that its private profits are worth less than the value of the damage it causes to the environment, that is to say we have to value the environment (in order to value the damage). But that would amount to moving the burden of the proof back on the environment.
- **high profits**: in these cases, it will not be possible to fight straight-away against the drivers because they do earn money. It does not mean they are beneficial for society either: the social costs could be very high (eg severe pollution). But it does mean that economic valuation of the adversary of biodiversity alone will not be a good enough advocacy tool and that we will need to go deeper into the analysis and use other tools. We can for instance try to split the activity into sub-activities, some of which may be losing money. But beyond this distributional aspects between sub-activities, we cannot really argue that a handful of people benefit from the high profits whereas other bear the social environmental costs (eg pollution) because, again, it would place the burden of the proof back on the environment.

Our typology can also be used to analyse the **effect of public money support for a driver**: does it increase the profits and move it from *breadwinner* to *intensive* ? It could also decrease the costs, for instance through tax rebates or by subsidizing inputs (an example of the famous *perverse subsidies*). If yes, then public money is maybe helping to destroy biodiversity.

We can also note that sectors with low costs are more likely to have high opportunity costs to change to a more environment-friendly practice and sectors with high costs are more likely to have low opportunity costs. Indeed, if the costs of doing business are already very low, it will be hard to find an alternative practice that has the same costs.

We also have to remember that economic values (profits) are not the only ones in town. They are only some of the values held by people. Employment, traditions, security, environment... are other possible advocacy registers and the struggle to protect the environment will not be over just by proving that drivers are unprofitable. But it still bring another argument to the advocates of biodiversity, and an argument that belongs to the economic register usually used by its adversaries that may often argue that “*protecting the environment is costly*”, “*environment and economic development are contradictory*”.

b. Technical tool

Our typology allows to determine which tools are *a priori* and in theory the fittest to change drivers and make them more environment-friendly if possible. In practise, the situation may be much more complicated, notably because economic efficiency is not sought after (**Chap. 3, II, C. Underlying model of decisions**) and because political motives or other hidden reasons may lie behind some *incompatible* drivers (**Chap. 4., II. B. 3. Decision processes that need obscurity or ambiguity assumption**).

Table 5- Classifying the drivers to see how to change them.

		Compatibility with the restoration of tigers		
		Synergistic	Compatible	Incompatible
Opportunity cost	High			
	Low			
	Negative			

If drivers are **synergistic** or **compatible** with the restoration of the tiger, then there is no need to change them, and in the first case, it may even be interesting for society to encourage them but that is not the topic of our thesis.

For *incompatible drivers*, adversary drivers, three situations can be encountered:

- **negative** opportunity cost: **information** and **technical support** on how to change for an alternative activity should be enough to change behaviours.
- **low** opportunity cost: as Laurans, Leménager, et al. (2011) rightly noted in their book about **Payments for Environmental Services** (PES), that is the best situation to implement PES. Other conditions must be fulfilled such as a State able to enforce justice, property, etc., clear providers of services (here the service would be preserving the tigers through tiger-friendly practices for instance), people willing to pay for them, etc. Actually, though we believe PES may be very good tools to incite adversaries of biodiversity to stop their harmful activities and move to practices that provide ecosystem services, we think it is not adapted for Hunchun situation. Low opportunity costs are fit for PES but also for other direct payments to or from the drivers because the monetary transfers needed to make the opportunity cost negative are low. Other monetary transfers could include: **taxes** or **bonus-malus schemes** such as the one initiated in France for cars (see Gouvernement français 2007), both applied on harmful production, or **subsidies** applied to environment-friendly practices.
- **high** opportunity cost: economic tools are likely to be unusable in these situations as the monetary transfers needed are too high and an efficient (applied to a large enough number of stakeholders) incentive would require huge sums of money that cannot realistically be mobilized. If the scale of the problem is very small, we can still imagine to apply economic incentive though. Regulatory tools are therefore required in the general situation: **prohibition** of the activity, **criminal penalties** (eg for poaching), allowance of a **limited number of licenses**... Whereas economic tools could be created by private actors such as NGOs, firms or consumers that want to protect biodiversity or some environmental services, regulatory tools are the prerogative of governments and it will probably need more tenacity from the environmental strategic actors before they can be implemented.

We are in a complex, strategic and intertwined world though and tools that may seem appropriate in theory may not work in reality. One reason is that the analyst may have not defined the driver correctly and have focused only of one of its activities whereas the driver has several complementary activities. In this case, the analyst may have underestimated the opportunity cost as relinquishing one activity will negatively affect the others. That is for example the case mentioned by Mermet (2003) of forestry road constructions in the French Alps and Pyrenees: the National Forestry Office very often lose money on these projects (so has a negative opportunity cost to change to the “do not build” alternative) but as building roads **(a)** justify for its number of

employees, **(b)** allow it to manage the forest and **(c)** participate in its statutory mission, it still promote such projects.

Sector-based actors may also disagree with hypothesis of our analysis and resist change or try to redefine the problem, a further obstacle to advocacy.

III. Analytical accountancy of the drivers

We have just described the tools that we will use to analyse the drivers but we first need data to characterize them. In this section, we report and work on such data to calculate the costs and profits of activity sectors.

Collecting these data seem quite simple but it is actually very fastidious as there is no identified and unique source of data and all the sources provide different figures.

A. Cattle husbandry

We will calculate the profit of this sector step by step. Several persons gave us orders of magnitude of the profit but they tended to be different and blind spots subsisted such as this one: how is it possible that farmers report extremely low profit when they seem to have very low costs ? So we decided to start from scratch and break down the profit to its elementary components.

1. Costs

The main costs stem from cattle feed. As cattle graze in **pastures in the forest most of the year**, feeds need to be provided to them only in winter. Actually, even in winter, they are not fed much as long as there is no snow. When snow covers the ground and cows cannot find anything by roaming inside the village, farmers provide them with feed in small cowsheds close to their house. Below we detail the consumption villagers (we only provide numbers to preserve anonymity) reported to us.

Table 6- Consumption of feed per head of cattle and per day reported by villagers.

Consumption per head and day	Source		
	[1]	[2]	[3]
Corn straw	10-25 kg	0.74 kg	0.93 kg
Soya bean		0.15 kg	0.69 kg
Corn flour	1-2.5 kg	0.22 kg	0.28 kg
Salt		0.04 kg	0.05 kg

[1] directly gave us data "per day and head of cattle" and they are very high. By contrast, we asked sources [2] and [3] to tell us the total amount of input they used for a whole winter and we then divided it by the number of days and heads of cows. We indeed believe that farmers are more able to remember the total quantity they used. Furthermore, source [1] is not currently raising cows, even though he did in the past. So we tend to trust more data from [2] and [3]. To check them, we compare them with data from France and with other elements we collected, the main one being that source [2] said **(1)** that he used 1 ton of straw during one winter and **(2)** that the production from his own field was almost enough for his cows but he had to get some (for free) from neighbours.

Table 7- Control of data about consumption: straw available.

	[2]'s asset	Inferred yield	Comparison with France
Corn straw	1 ha of corn out of 4 ha of land	1 t/ha (average yield in Chunhua for corn <u>grain</u> : 1.395t/ha ⁴ but yields for grain and straw are quite similar)	Yield: 10 t DM/ha ⁵

As [2] has 1 ha of corn and he consumed 1 ton of straw, it means his yield is about 1 t/ha for straw (it should actually be less as he obtained some straw from neighbours). It seems a bit inferior to 2009 yield for his town, Chunhua. What is more, other villagers reported a 5 t/ha yield in the same village. So it is likely that [2] underestimated the quantity of straw he used.

Table 8- Comparison of consumption figures with France and summary of figures for the consumption per head and day we keep for the rest of the analysis.

	Consumption, figures range ⁶	Figures eventually kept	Comparison with France ⁷
Corn straw	0.74 kg to 25kg.	0.93 kg	6 kg
Soya bean	0.15 kg to 0.69 kg	0.69 kg	1 kg
Corn flour	0.22 kg to 2.5 kg	0.28 kg	
Salt	0.04 kg to 0.05 kg	0.05 kg	

We decided to keep [3]'s values, even though we still think it is an underestimation of real consumption. To our reader that may think that values in France dramatically exceed those in Hunchun and so we may have seriously underestimated values in Hunchun, we answer that several people reported that cattle are under-fed during winter. This is confirmed by the fact that farmers prefer to sell cattle in Autumn, when they come back from pastures because that is when they are the fattest. In the end, even though we may have underestimated consumption, the underestimation should not be too severe.

Now that we know consumption, we can calculate costs for farmers. We considered different kinds of costs reported in the table below:

- costs really borne by farmers ((c) + (d) in table 9): (c) the feed they have to pay to provide to their cattle in winter and (d) the opportunity cost of the forfeited sales of the fraction of their own production that they give to their cows in winter (if they had no cows, they could sell it instead). **(d) is not actually paid by the farmers so it does not affect their *apparent profits* for the "livestock husbandry" activity but it does affect the total household profit.** (c) is actually the transformation cost of soya into soya bean and corn grain into corn flour, to which we add the costs for salt. Farmers indeed use their own harvest to feed their cattle so they do not need to buy additional feeds.

4 From Hunchun's Government (2009)'s statistics.

5 <http://www.anjou-agricole.com/actualites/grandes-cultures-fourrages-recolte-de-mais-ensilage-des-situations-tres-heterogenes&fldSearch=QGSKCKRG.html>

6 This column shows the range of consumption that was reported to us.

7 http://www.inst-elevage.asso.fr/IMG/pdf/923-Proteag_BV-complet.pdf and http://www.inst-elevage.asso.fr/spip.php?page=article_espace&id_espace=944&id_article=19894#ancr2

Table 9- Costs really borne by farmers, including opportunity costs.

	Consumption per head and day	Transformation cost (RMB/jin ⁸)	Opportunity cost (sell price) (RMB/jin)	Total cost per head and day (RMB) ⁹
Corn straw	0.93 kg	NA	0	0
Soya bean cake	0.69 kg	0.15	2.5	0.01042
Corn flour	0.28 kg	0.03	2	0.0077
Salt	0.05 kg	NA	NA	0.14

- lost potential profit ((b1) + (b2) in table 9): the loss to tigers and other natural reasons. Farmers do not pay for them and would not lose any money either if they did not raise cattle so they are not opportunity costs. But without these "costs", the profits would be higher. We evaluate (b2) by considering 13% of livestock die for any natural reason every year¹⁰ and that it could have brought an income equals to the sell price (5000RMB) time the number of heads which died (here it is time 1 because we consider the cost per cattle and per year so here, we assume 0.13 head of cattle died). As cows are sold only after they are 5 years old (the exact age actually depends on our assumptions as we will see below, but here we will consider that they are sold exactly at 5), we have to divide by 5. Then we retrench (b1) to this figure to get (b2) (see *infra* for details about the calculation).
- costs borne by society in place of the farmers ((e) in table 9): all the vet costs subsidized and paid by taxpayers.
- avoided costs thanks to the forest ((a) in table 9): the provisioning services provided by the forest: free feed for cows during most of the year. We used the costs calculated in (c) and (d) to assess it. That is to say we considered the value of the provisioning services was equal to the costs farmers would have borne if they had to buy feeds for their cattle in summer instead of simply letting them graze in the forests for free. So concretely, we multiplied the costs per day calculated with (c) and (d) by the number of days spent in the forest.

We did not consider the following costs because, according to our knowledge, they are very low:

- cost of the **construction of cowsheds**.
- **fees for the use of communal pastures** (we indirectly heard of such fees once but never directly heard of them or got any figure, see Chin 2011).
- **other vet fees** that are not subsidized. They are either very low or if they were to be high, farmers just don't pay and let the cattle die and sell it for half the price (see below, when we deal with profits).
- **artificial insemination** costs were ignored not because they are low (100-200RMB per successful insemination usually) but because they are not usual in our main area of concern: the town of Chunhua.
- **time opportunity cost**: the time spent for cattle husbandry could be spent on another more

⁸ 1 jin (斤) equals 500g.

⁹ This column is the product of the consumption per head and day multiplied by the transformation cost.

¹⁰ This 13% figure comes from WCS Summer 2011 survey during which more than 100 households in Hunchun's area, in particular Chunhua's area were interviewed. One question asked about their average natural loss of cattle.

profitable activity which means time presents an opportunity cost. However, farmers spend very little time for cattle husbandry and it is never their priority (for instance, in April, if they have not finished their planting work on the fields, they will not take time to bring cattle to the pastures and instead wait until their field works are finished before they take care of cattle). In summer, they may watch them in the pastures when they have time but probably not every day (and sometimes they may check their cattle not more than once a week). In winter, they just need to provide them with some feed three times a day and they do not have much else to do at this time of the year. This opportunity cost should be negligible.

- **transaction costs** : when farmers sell (or buy) their cattle, there may be a transaction cost. We lack data about it and so are unable to put a figure on it (though we heard of 450 RMB).

Table 10- Costs to raise cattle per head and year.

Costs	Value in RMB per head of cattle and year
(a) Services provided for free: pastures in the forest . Evaluated with costs (c) and (d) expressed for the 7.5 non-winter month.	1071.3
(b1) Average loss to tigers evaluated through the applications for compensation (compared with the reported loss from B. Li et al. 2009 in figure 4 below) ¹¹ . This is evaluated in Chunhua town which is one of the most subject to attacks by tigers.	7.84
(b2) Other natural loss : disease, lost in the forest.	122.16
(c) Feed , in winter season (extended: from December to mid-April, 4 month and half).	33.6
(d) Opportunity cost to feed cattle with one's own crops (soya bean and corn grain).	618.75
(e) Medicines , vaccines and associated vet fees provided for free	? ¹²

If we do not take into account the opportunity cost (d) of foregone soya and corn, the costs for farmers (c) are quite low and do not reach 40 RMB per head and year. But with the costs of foregone soya taken into account, the situation is very different, about 90 kg of soya beans means more than 450 RMB as you can sell soya for 5 RMB per kg¹³ (to get this price, we crossed several sources: **(1)** from villagers in Lanjia, we know a soya field can produce 2000 kg/ha and from WCS

11 78 400RMB were paid for the compensation of 20 heads of cattle killed by tigers in 2010 in Chunhua (345 300RMB and 76 kills for the whole Hunchun). There is in total about 10 000 heads of cattle in Chunhua according to both Hunchun's Government (2009) and statistics obtained directly from Chunhua government. The average loss per head and per year is therefore 7.84RMB and there is a 0.2% risk for a head of cattle to be killed (to be more rigorous, we should consider an average on several years but data are missing and as we show with figure 4 using data from B. Li et al. (2009), losses stabilized in recent years and we assume they will not increase in the years to come).

12 We were not able to estimate this cost but it should be less than 200 RMB per head and year according to data collected during WCS Summer 2011 survey.

13 <http://www.xumu.com.cn/html/market/0219/2011/0810/223646.html>

Summer 2011 survey, we know it translates into about 10000 RMB/ha at sell price which means 5 RMB/kg, and (2) internet sources also report a price of 5 RMB/kg). When you add the opportunity cost of corn flour, you reach almost 620 RMB/head and year. It also greatly increase the value of forest provisioning services because farmers would need to provide cattle with their own corn straw, soya and corn flour for an additional 7.5 month without forests. It is actually possible that they could not produce enough so they would have to buy outside (which would reduce the transformation costs we included to assess the value of the services provided by the forest but it is only 25.73 RMB out of 1071.3 RMB). The forest ecoservices are likely to be underestimated for at least two reasons: (1) as we mentioned, cattle are under-fed during winter so if farmers had to feed their cows all year round, they would probably have to provide them with more feed (not to mention that our estimation of consumption is underestimated as we acknowledged); (2) in the current situation, cattle raisers can use their own corn straw and if they lack some, they can obtain it for free from neighbours so we valued its avoided cost during summer at zero but if they had to feed cattle the whole year, farmers would surely have to pay to buy straw (or alternative feed) because the supply would be too limited, this would further increase the value of forest ecoservices.

At that point of our reasoning, it appears cattle husbandry make a loss because of high opportunity costs of the feed provided to cattle. But do compensations provide a significant support to this activity sector ? Does it translate into a *perverse incentive* powerful enough to transform a non-profitable business into a profitable one ?

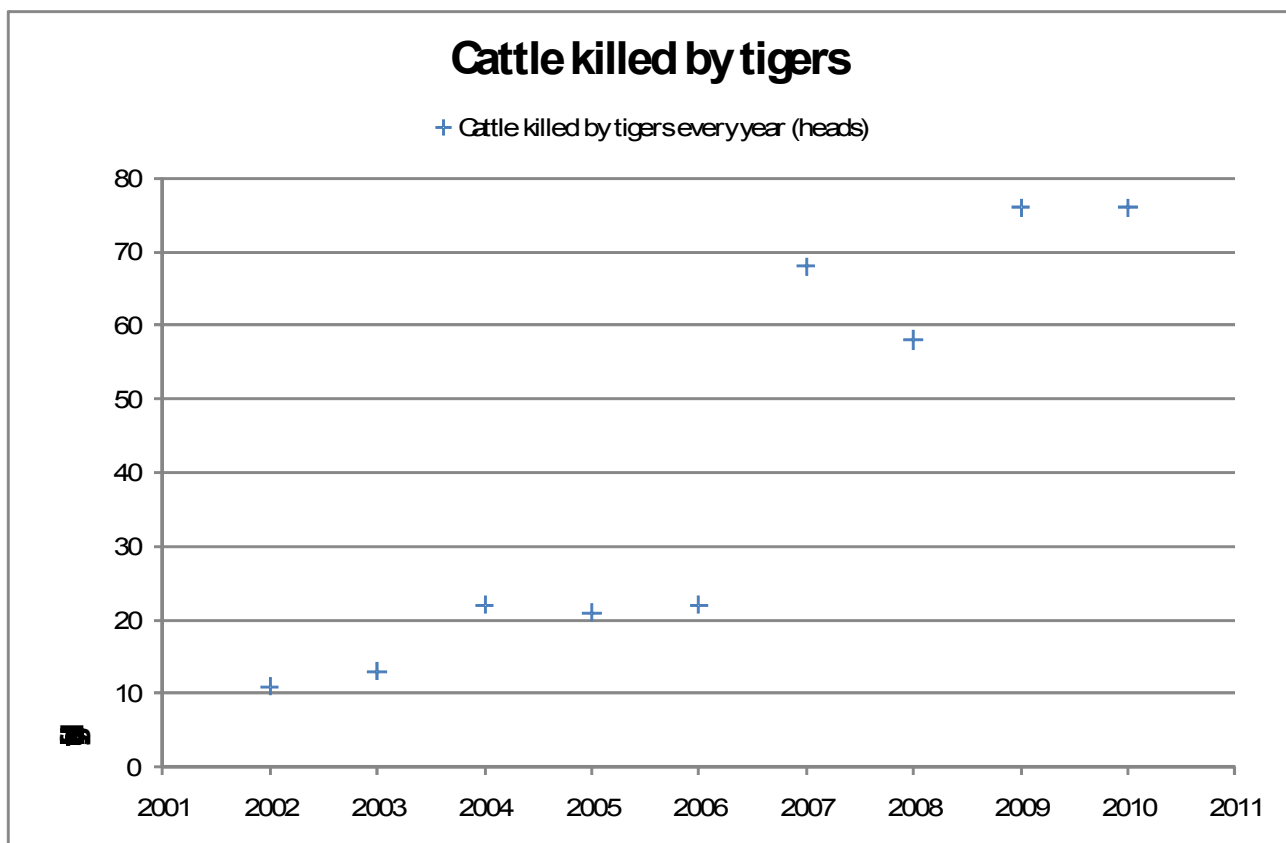


Figure 4- Cattle killed by tigers in Hunchun - Data from 2002 to 2007 are from B. Li et al. (2009) and from 2008 to 2010, they are from discussions with the Compensation Bureau of Hunchun.

The figure represents the number of cattle killed by tigers every year according to two different sources. The two sets of data (those from the Compensation Bureau and those from B. Li et al.) are satisfactorily coherent and we conclude that we can trust data from the Compensation Bureau so we

keep our average cost of 7.84 RMB/year and head of cattle because of loss caused by tigers. The average cost is excessively low, however it varies from place to place: **villages closer to the border and the Nature Reserve are more likely to experience attacks by tigers** and some villages may have loss rate closer to some percent rather than some tenth of percent.

Losses to the tigers seem to be much lower than loss for other reasons (disease, lost, snares). Villagers we met during our field work did not complain much about loss to tigers (they were much more angry at wild boars) which tends to confirm low level of losses. With the caveat we just mentioned that some villages may experience much higher level of loss and be angry at tigers, our field work points to low level of resentment toward tigers which should facilitate conservation objectives. Nevertheless, if population of tigers are successfully restored, losses are likely to increase because more tigers mean more predators ready to attack cattle. Paradoxically, it seems that the more restoration of tigers will progress, the more difficult it will become to pursue.

2. Minimum herd size

We look for the lowest number of heads of cattle a household can have to be “self sustainable” (ie to have enough reproductive cows so that the number of calving compensate sales and deaths and no purchase is needed) and then we calculate its profits. We can then compare (i) the real situations we encountered and (ii) the average real situation (that we calculate based on (ii)) with (iii) this optimal situation to infer the expected profits actual farmers should make (directly asking to the farmers gave unreliable data and we have to calculate profits back from scratch).

Our calculations will be based on assumptions that we detail in the next table. We formulated two sets of assumptions: the *basic assumptions* and the *more realist assumptions*. The differences concern two issues: *basic assumptions* consider farmers manage to have one calving every 365 days with the same cow, which correspond to what most farmers told us and what WCS believes. As we deal with meat cows and not dairy cows and as farmers mainly use natural bulls who stay with the cows and they do not use artificial insemination, this figure is plausible. However, Hunchun own statistics (Hunchun’s Government 2009) tend to show that the time between two calving exceed one year and with such an extensive, unmonitored system, it also seem likely that the efficiency does not reach one calving per year. The second difference concerns the number of deaths for any natural reasons. To simplify matters and get a rough idea of the minimum herd size, we considered the simple case of zero loss with *basic assumptions*. It is not realistic at all and our field data are used for the *more realist assumptions*.

Another key assumption is that farmers want to sell one head of cattle every year. That assumption may not be realist as it appears some farmer did not sell any cattle some years but it is a great simplification for calculation and a limit condition that allows to find a minimum size (otherwise, a farmer could even have, say, 4 heads of cattle and sell one every 5 years). Though not exact, this assumption reflects the aim of farmers. Farmers we met and who did not sell did so because they had great losses the previous year. but selling one head of cattle a year still represent their objective.

Table 11- Calculation assumptions to find the minimum herd size.

	<i>Basic</i>	<i>More realist</i>
Number of days between 2 calving	365 (1 year)	429 ¹⁴
Sex ratio	0.5	
Death of cattle for natural reasons	0	13% of livestock ¹⁵
Sell age	5 years old (60 month old) or later ¹⁶	
Minimum sell per year	1	

With *basic assumptions*, it is necessary to have at least **8 heads of cattle**, otherwise it is not possible to sell at least one 5 years old or older head of cattle every year. With *more realist assumptions*, if we note N the number of heads of cattle in any given year, then every year:

- **(1)** $0.13N$ will die for natural reasons (killed by tigers, lost in the forest, sickness)
- **(2)** $(\frac{N}{2}) * (\frac{365}{429}) * (\frac{3}{5})$ will be borne ($N/2$ = number of females and in average only 3 out of 5 are between 3 and 5 years old so able to give birth). We consider the **worst case scenario** with all the cattle that died for natural reasons being reproductive females. It means we have to further multiply this by 0.87.
- **(3)** a certain additional proportion will be sold: $x * N$

To have a constant size of the herd, we must have **(1) = (2) + (3)** which means $x = 0.09$. It means cattle cannot be all sold at 5 years old (it would require a one in five, $x = 0.2$, rate of sales), and that is true whatever N, the size of the livestock. So to keep selling one head every year with *more realist assumptions*, unlike the case with basic assumptions, **it will be hard to sell 5 years old cattle**, many of them will be older when they are sold. Furthermore, N must be equal at least to **11 heads of cattle** ($1/0.09$).

In Hunchun, we saw many households with less than 11 heads of cattle. **They indeed were selling less than one head of cattle every year**, but they could - not fully legally though - sell their sick cattle for a small sum (eg 2000 RMB instead of 4000 RMB for the full price). As we consider dead cattle have a zero market value, we underestimate the profit that can be made with 11 heads of cattle.

3. Profit

We detail the profit with both assumptions in table 12 below. We **first** give general data **then** we break down the figures per head and **in a third part of the table** we provide figures for the whole herd. Profits are in **green-like colours** and costs are in **red-like colours**.

14 Figure based on Hunchun's Government (2009)'s statistics. We calculated this figure based on the total number of births and the total number of cattle in 2009.

15 This is based on a survey co-conducted by the author for WCS. We asked for the total number of death for any reasons during the last 3 years to 82 households in Chunhua town (and more than 100 households in total). We then divided this number by the current number of cows owned by the household and annualized it by dividing by 3. So that is an approximation of the average (because the number of cows is not constant year after year)

16 Farmers reported a sale age of 3-4 years old but it does not seem realistic at all. When we went deeper into interviews, we realized that (1) they had cows older than 4 years old and (2) they considered the price to be too low at 3-4 years old. What is more, selling cows at 3-4 years old would require a too pool of cattle too numerous in order that calving compensate the sales. So even with the "basic" assumptions, we consider only 5 years old.

Table 12- Profit break down for cattle husbandry (the letters into brackets refer to table 10).

		With <i>basic assumptions</i>	With <i>more realist assumptions</i>
Data per head(RMB/head and year)	(1) Number of heads of cattle	8	11
	(2) Births (heads per year)	2.4	2.44
	(3) Deaths for natural reasons (heads per year)	0	1.43
	(4) = (2)-(3) Sells (heads per year)	2.4	1.01
	(5) Unit price (RMB/head)	5000 ¹⁷	
	(6) = (4)*(5) Sale earnings (RMB/year)	12000	5050
	(7) = (6)/(1) Sale earnings per head	1500	459.09
	(8) <u>Apparent</u> private costs Feed transformation costs (c)	33.6	
	(9) = (7)-(8) <u>Apparent</u> profit without compensation	1466.40	425.49
	(10) <u>Real</u> private costs Feed transformation and opportunity costs (c)+(d)	652.35	
	(11) = (9)-(10) <u>Real</u> private profit without compensation	847.65	-193.26
	(12) Average compensation(b1)	7.84	
	(13) = (11)+(12) (Real) private profit with compensation	855.49	-185.42
	(14) Avoided costs thanks to free forest pastures (a)	1071.3	
	(15) = (13)-(14) (Real) private profit without compensation and without free pastures	-223.65	-1264.56
	(16) Potential additional profit through avoided loss (b2)	122.16	
	(17) Vet related costs borne by society (e)	? ¹⁸	
Data for the herd (RMB/year)	(18) = (8)*(1) Total <u>apparent</u> costs	899.92	1237.39
	(19) = (9)*(1) <u>Apparent</u> profit	111731.2	4680.4 ¹⁹
	(20) = (10)*(1) Total <u>real</u> costs	5218.8	7175.85
	(21) = (11)*(1) <u>Real</u> profit	6781.2	-2125.85

17 This price is subject to discussion, price varies greatly according to the weight (and therefore age, sex and breed) of cattle. According to the survey I participated in for WCS, farmers' best cows can fetch prices that can reach 8000-10,000RMB. The likely interval for the average price is 4000-6000RMB.

18 We lack data to calculate, see table 10.

19 Farmers may consider they could have received an even greater profit by adding (b1) and (b2) the loss to tigers and to other natural causes., which form their lost potential profits. Actually, the lost potential profits is even greater as without the loss, we could be in *basic assumption* "corrected" with 429 days between two calving. That would mean higher earnings and lower costs (because of more birth and less heads necessary for self-sufficiency).

Costs are proportional to the herd size so we mainly expressed them per head and year. Aggregated profit is calculated differently between the two assumptions because the number of sales per head of cattle and year is different (1.01 every 11 heads with *more realist assumptions* and 2.4 every 8 heads with *basic assumptions*) and so the line (7) sales earnings per head presents different value for the two hypothesis. But profits are also proportional to the herd size.

This table shows very interesting results. **In a first step**, if we consider only the livestock husbandry activity and the money farmers really have to spend (what we call *apparent costs*), then, though low, a profit is made - even with *more realist assumptions* -. Farmers can earn about 425.49 RMB/head or 4700 RMB with 11 heads - every year. This is possible because apparent costs are very low and consist only of transformation costs of soya into soya bean and corn into corn flour (we said above we ignore costs such as cowshed building, etc. which are very low too). But other costs also exist for livestock husbandry when we consider a more relevant system: the household as a whole. The soya and corn eaten by the cattle in winter could have been sold and have an opportunity cost. Not a single farmer mentioned this cost to us though; that may show that they do not consider it as a cost. **In a second step**, we can now calculate the *real costs* which are both the transformation costs (*apparent costs*) and the opportunity costs of feeds. These *real costs* are much higher and make the *real profits* with *more realist assumptions* become negative.

Livestock husbandry is therefore a non-profitable activity because (1) the opportunity costs of using corn and soya to feed cattle in winter is too high (costs of 618.75RMB/head and year whereas the costs that would cancel the profits is 459.09RMB/head and year) and (2) the high loss percentage it suffers and its consequence on the reduced number of heads sold every year. With 0 loss, the herd size could be smaller which means lower costs and more heads could be sold every year which means more money earned every year.

We considered a herd size of 11 heads of cattle in the *more realist assumptions* because it is the minimum herd size if farmers want to sell one head of cattle every year under these assumptions. All costs and benefits (but they are different according to the set of assumptions chosen) are proportional to the number of herd size, so the profit is also proportional to it: **there is a constant negative profit per head**. In reality though, some **fixed costs** we previously ignored exist: the price of the cowshed, the time to spend for cattle husbandry is not directly proportional (farmers will not spend twice as much time if they have 4 heads of cattle instead of 2). But there is no fixed benefits, so the profits are likely to be relatively smaller for smaller herd and farmers with those more reduced herd should be worse off (but if we do not take into account these fixed costs, the smaller the herd, the “less negative” the profits).

In a third step, we calculate in line (12) the average compensation farmers receive every year (this represents a value per head of cattle so it must be multiplied by the size of the herd). It is clearly not sufficient to bring back the real private profit into positive with the *more realist assumptions* set (we come back on this result later in this Chapter).

In a fourth step, when we further take into account the services provided by forest pastures - line (14) -, the profits are negative whatever the assumptions we consider. Forest ecoservices (or equivalent pastures services near river...) are central to the traditional livestock husbandry and without them, farmers would have to spend significantly more money to feed their cattle in summer. This would probably mean the end of cattle husbandry for many farmers unable to make the activity profitable.

In a fifth step, we consider two other figures to evaluate their effect on the profits. **Natural losses**, if avoided, would provide farmers with an additional profit because cattle that died could instead be sold when they reach five years old (or later). But this does not tip back the loss into profit either. Finally, without the **subsidies of the State** (the costs of which are borne by taxpayers and so form social costs) **to buy medicines, vaccines and for the vet services**, farmers' costs would further inflate. We unfortunately lack data about them so we cannot evaluate their significance in the profit build up.

In a sixth step - lines (18) to (21) -, we calculate the aggregated costs and profits in order to compare them with those of other activities in the **IV of this Chapter**.

To confirm our results, we can consider the estimated feed costs described in the Banshi county (板石镇)'s report about their plan for a cattle stall-feeding program (Banshi's People Government 2011). They plan costs of 4000 RMB for 18 month stall-feeding for one head of cattle, which means about 2666 RMB per year. Our 625.35 RMB/head and year compares well with their estimated costs as it is the cost associated to under-feeding and not to stall-feeding as in Banshi's case.

B. Crop production

We lack detailed data about crop production but we can use raw data we collected both alone and with WCS during their Summer 2011 survey. Roughly, revenues fall between 5000 and 15000 RMB per hectare, with soya revenues likely to be lower than corn revenues. Profit is about half to two third of the revenues. **It seems realistic for us to consider a revenue of 10000 RMB/ha and costs of 4000 RMB/ha for both corn and soya.**

We summarize the meagre data we possess in the two following tables. The second one offers some worthwhile data: subsidy amounts that the Central Government pays to farmers.

Table 13- Costs (RMB/ha) of growing crops.

	Corn	Soya
Urea	150 kg (3 bags); unknown price	
Seeds	Hybrid seeds: 880 RMB	unknown

Table 14- Gains of growing crops (source: villagers in Lanjia except for price of corn and soya: internet).

	Corn	Soya
Subsidy for growing crops	70 RMB/mu = 1050 RMB/ha for growing crops	
Subsidy for seeds	10 RMB/mu = 150 RMB/ha for seeds	
Yield	5000 kg/ha	2000 kg / ha

Farmers also receive support from government to buy mechanic tractors and fuel to drive them. We were unable to quantify this help.

C. The typical household model

To extend the analytical accountancy and express results in a way that may be more immediate to

understand, we developed some tools that bring the focus on aspects we consider as keys to assess the possibility to change drivers' behaviour, especially if economic incentives are considered. This section also gathers the data available about households' income and we choose to represent the situation of the average, *typical*, household and not all the diversity of situations. Households' living conditions and activities are indeed quite uniform, except for some cases that we detail in the **4. Special cases**.

The tools we offer are **first**, a **dashboard** of the choices faced by households that can help to visualize its incentives, **second** incomes are not static gains and losses of money, costs may be spread over the years and income happen only once every few years, so to compare two alternatives for households, we need to see **how the revenue is formed** over time, **third** to understand who or what has influence on households, we need to look at their **reliance** on different income sources.

We have to warn our reader that these tools have not been much developed yet and are at the stage of design and test. Further research are needed to test their ability both **(1)** to summarize and efficiently display relevant information and **(2)** to be used by *strategic environmental actors*.

1. Choices faced by the household: a dashboard for visualization

To understand a rural household, many factors have to be taken into account and though we lacked skills in sociology and ethnography, we tried our best to produce a relevant and accurate analysis. Several factors have been identified to shape attitudes of rural households' extraction of natural goods (Coomes et al. 2004; Takasaki et al. 2000) and we list them in the blue polygon in the figure below. Cultural factors also of course play a major role. In addition to these assets-related, socio-economic, environment and cultural factors, our main focus turns on positive and negative monetary incentives. We produced the dashboard reproduced below for two main reasons:

- **concentrate data** in one place to visualize them all at once which is useful for the researcher as much as for users of his results.
- **make data easier and faster to grab**. We also added indicators that go further than simple raw data such as “**net flux per year**” and “**number of employees**” because the first one is useful to go deeper into the comparison of alternatives and the latter answers some of policy makers' preoccupation.

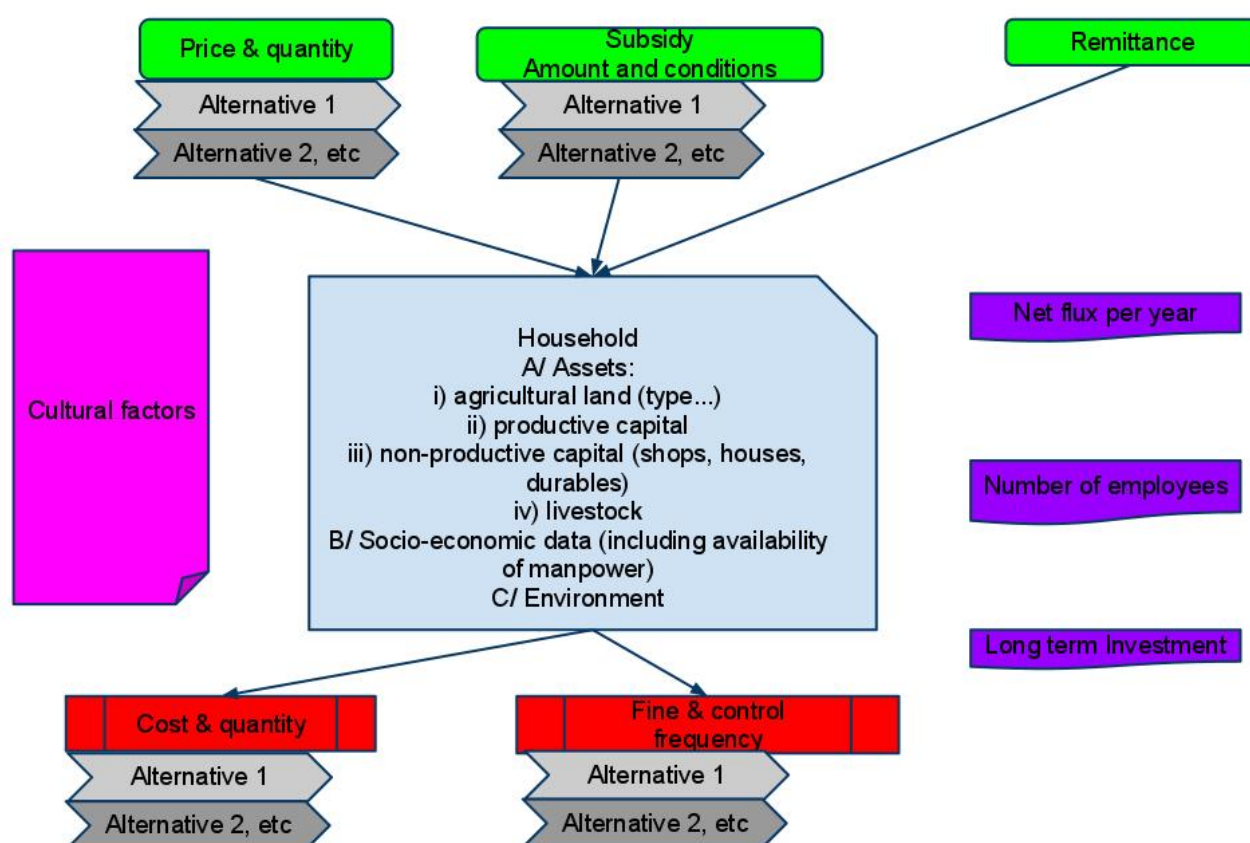


Figure 5- Extension of the analytical accountancy: a dashboard to visualize data.

Ideally, such a dashboard would be filled for the whole household and lists all its alternatives. Unfortunately, in our illustration, we only deal with livestock husbandry because we have to cope with our lack of data about precise incentives in other activities.

The colours were chosen as follow: **green** for positive incentives (money gained), **red** for negative incentives (money lost) and shades of **grey** for the different alternatives or choices that the household faces. The shapes in the middle of the figure are not economic incentives and have their own colours, they are either factors other than economic or, on the right, analyst's indicators.

We believe this dashboard can especially support comparison of different alternatives. It is not necessary to represent all the possible alternatives, they should on the contrary be chosen for their relevance to solve the environmental issue. For instance, for an *incompatible driver*, one should represent the current *de facto* situation and then a *compatible* alternative. The dashboard also helps the researcher to identify more clearly the data he needs to get.

In the figure below, we consider a household with eight heads of cattle and most of the data come from **III.A. Cattle husbandry** of this Chapter. For alternative 1, we consider the *more realist assumptions* defined *supra* (that implies 0.78 head of cattle sold every year). For alternative 2, which corresponds to stall-feeding, we consider also a eight heads of cattle herd and to simplify we assume there is the same mortality as with traditional husbandry so the only differences are **(1)** the sell price which is 10,000 RMB/head instead of 5000 RMB/head and **(2)** the costs. For the costs, it is a bit complicated to calculate them as some heads of cattle are reproductive cows which are not

stall fed (so have the same costs as the traditional method) and others, the bulls, are stall-fed 18 months. To simplify and because we only want to illustrate our tools (if we wanted to use the data to devise an incentive program, we would need to be more precise), we consider a yearly cost per head of cattle that is the mean between the cost for cows : 652 RMB, and the cost for bull : about 1460 RMB (3000 RMB for the 18 months of stall-feeding according to Banshi's people government 2011 and 652 RMB for the first year). **So the costs we consider is 1056 RMB/head and year**, it is likely to be an overestimation (because there are more cows than bulls as bulls are sold every two years and a half). We also underestimate the gains here because with stall-feeding, the mortality rate is likely to decrease as bulls spend less time in the forest and farmers may pay more attention to their cattle (but that second effect would increase farmers' costs).

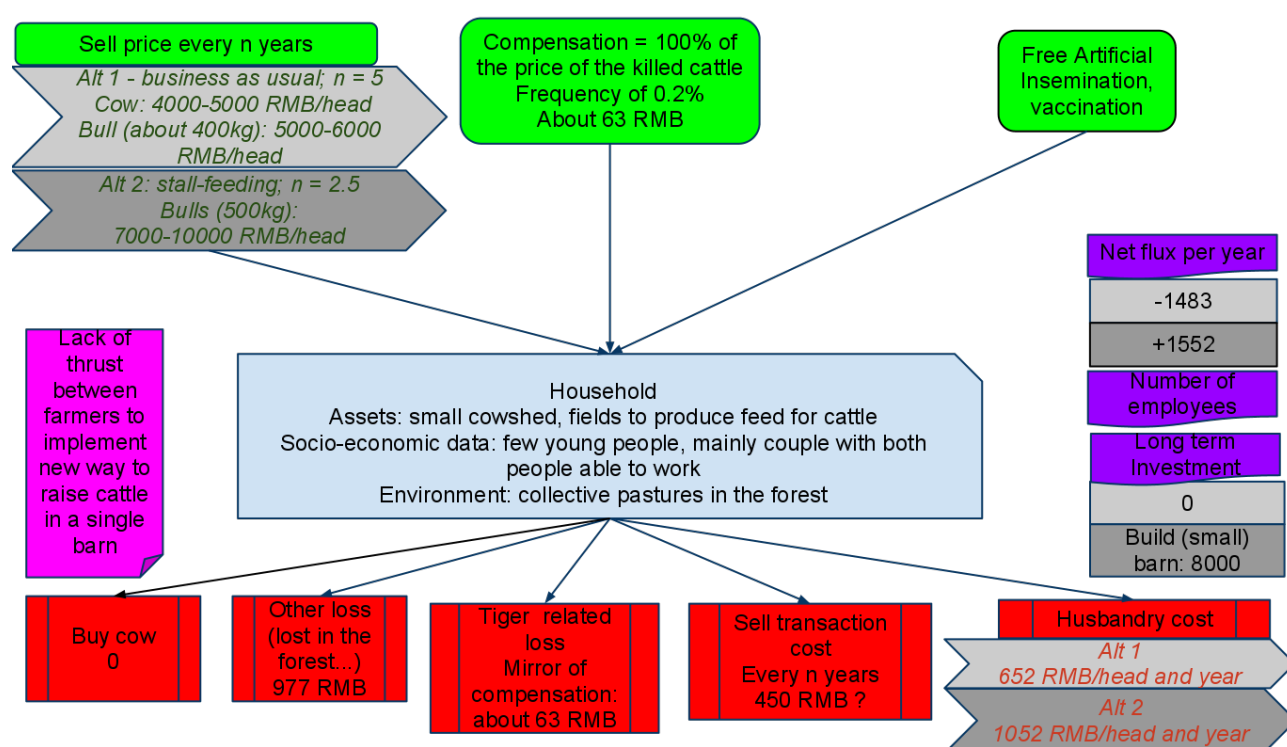


Figure 6- Illustration of the analytical accountancy dashboard with cattle husbandry. External source: Banshi's people government (2011)

What we learn with this figure is that economic incentives are in favour of stall-feeding, the darker shade of grey in the figure, even though they are lower than expected: (Banshi's People Government 2011) calculated a 3000 RMB/head and 18 month whereas we calculate only a 1552 RMB/year profit for eight heads of cattle (but they considered buying one year old head of cattle for 4000 RMB). But social factors are against at least one form of stall-feeding which corresponds to collectively raising cattle in a single collective barn. However, this analysis needs to be completed by a comparison of the revenue formation of the two alternatives (see **2. Revenue formation** below).

Why are the profits so disappointingly low compared to Banshi's government's forecast ? Because we chose a model with breeding cows that therefore need to be fed but do not directly bring money; and because all the cattle first spend one year in the forest where they can be killed by tigers or die of other natural reasons, which greatly decrease the efficiency of husbandry.

This illustration of our dashboard is however quite useless for *strategic environmental actors* because both alternatives: traditional husbandry and stall-feeding are not *compatible* with our *reference objective* (see **IV. Classification of drivers in Hunchun in the same Chapter**). We can however imagine applying the same tools to a more relevant situation.

2. Revenue formation

If a NGO such as WCS identifies an activity it believes is beneficial for tiger conservation and wants as many households as possible to adopt it, then it needs to think beyond costs and gains balance. It needs to consider when these money fluxes happen. As we will show in **IV. Classification of drivers in Hunchun in this Chapter**, traditional cattle husbandry is an *auxiliary activity* that does not earn much money and have limited costs, but people keep pursuing it instead of switching to more *intensive activities* because it does not require big initial investments and costs are not only always low but also distributed all over time (and not concentrated).

So we offer to draw the money fluxes and the cumulated fluxes over the relevant production period, which for cattle is the lifetime of a typical head of cattle (we do not deal with a discount rate but it may actually be more appropriate and relevant to draw the discounted value instead of the current value). We compare different alternatives, here traditional husbandry and stall-feeding.

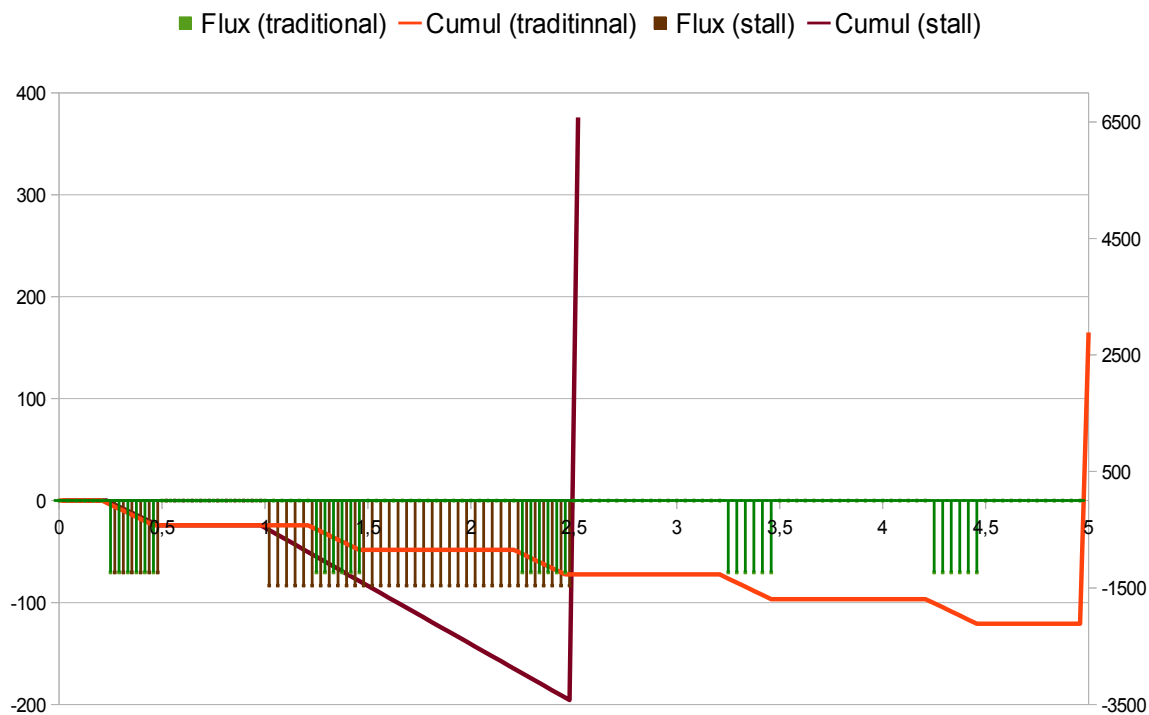


Figure 7- Comparison of cumulated money fluxes for traditional cattle husbandry and stall-feeding.

Here, we did not consider a whole household but only the costs to feed a head of cattle and then the gain when it is sold. The positive flux corresponding to the sale of the head of cattle is not shown on the figure; it is out of the scale: +10,000 RMB for stall feeding at 2.5 years old and +5000 RMB for traditional husbandry at 5 years old. The first year is identical for the two methods of husbandry. We can clearly visualize here that if stall-feeding earns a higher profit, it is also associated with much higher costs: just before the cattle is sold, cumulated costs have reached 3500 RMB, whereas at the same time (2.5 years), costs for traditional husbandry have not reached 1500 RMB. **So we unveil here a potential reason why farmers do not abandon traditional methods for stall-feeding even though the profits may be higher.**

When we consider a household and not just a single head of cattle, we depict a more accurate picture. Bulls do not appear out of nowhere and they need a breeding cow to be their mother, this breeding cow can itself die in the forest so a bull actually needs (in average) more than one breeding cow to be born. In the end, a herd with eight heads of cattle is not able to sell one bull every year according to our calculations with *more realist assumptions*. In the figure below, we represent the fluxes (in **green**) and cumulated fluxes (the **orange** line) for such an household with eight heads of cattle. We also show services that do not possess a market price but can be evaluated in **blue**. These services correspond to the feed provided freely by forests and to losses caused by tigers or other natural events and that could have translated into sales in the long term.

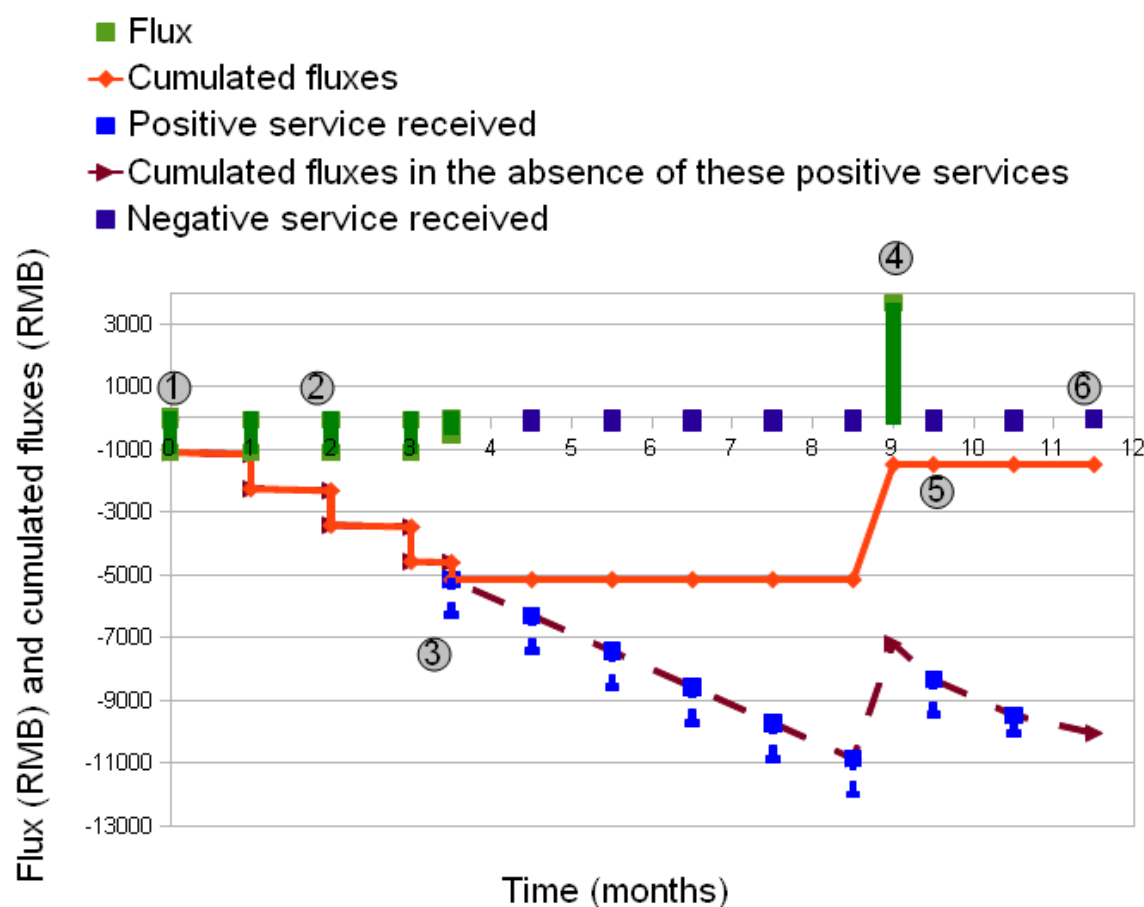


Figure 8- Monetised fluxes and non-monetised services and how they form livestock husbandry revenue for a typical household.

Here is a brief comment associated to the numbered circles:

1. we start the time line in December, month 0.
2. in winter (December to mid-April), farmers have to feed their cattle which induces negative money fluxes (we represent monthly fluxes so the last negative green fluxes is pictured with half the value of the other because it corresponds to half a month).
3. in summer, cattle are in forest pastures: farmers benefit from forest provisioning services that have the same (absolute) value as the winter's feed negative money fluxes (this is indeed how we calculated them: equal to the winter's feeding costs) and are drawn in blue. Without these fluxes, farmers would have to pay to feed their cattle and we represent the cumulated fluxes that would occur in such a situation in dotted brown: the activity would clearly suffer very severe losses
4. in September, 0.78 head of cattle is sold on average (ie 7.8 heads every ten years), which triggers a positive flux of money.
5. but it is not enough to make the cumulated fluxes positive over a year.
6. we represent the loss of potential profit caused by natural losses (see *supra*) in dark blue. It is negligible.

3. Reliance on income sources

Finally, if one wants to determine which agents can exert a leverage on households to incite them to modify their behaviour, it is critical to study their sources of income. To determine what is the *source* of gain or loss, we considered:

- what **produced** the good **sold**: eg for cattle sold, we considered the source is “own asset”, whereas for mushrooms collected in the forest, the source is “forest” and for government's subsidies, it is one of the government sources (see **Appendix A** for details)
- who/what **provided** the good **bought** or **causing a loss** (eg the opportunity cost of soya's source is cattle so “own assets” but the source of seeds, fertilizers, etc. bought for the crops is “Hunchun's market”). It means the origin of most of the costs is Hunchun's market even though the goods bought may be used by household's own assets. Maybe we should have considered the costs of what is essential to the exploitation of own assets stem from these own assets (so seeds' source would be “own assets”) but this matter is anyway not really important as we are not interested in the costs but on the gains.

We drew the map of income sources from data about households' income from WCS Summer 2011 survey and from our own field data.

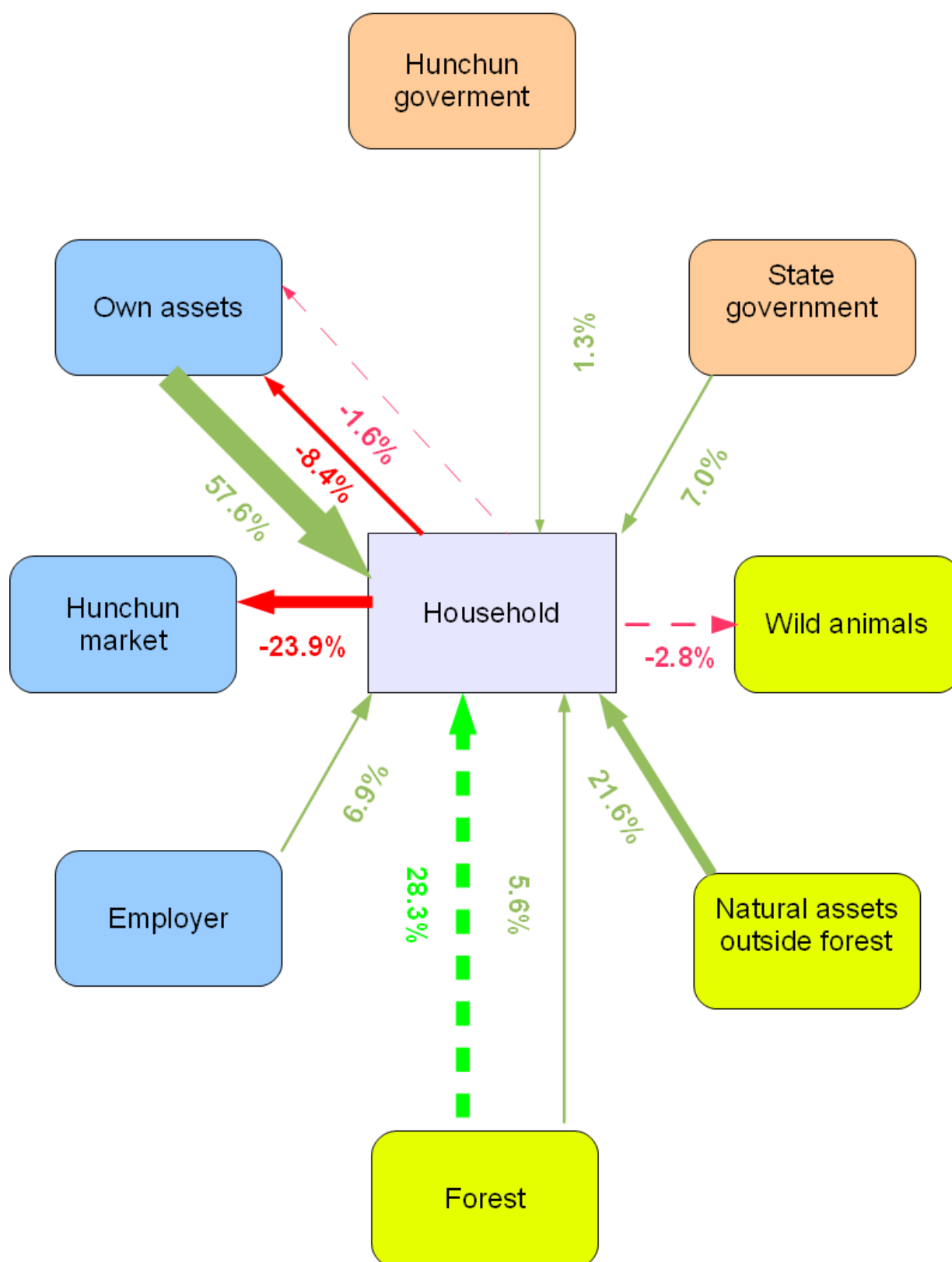


Figure 9- Household's reliance on each source of income.

Dotted lines are services or goods that are not exchanged on the market (loss of cattle to “wild animals” and for other natural reasons for “own assets” and provisioning services provided by the “forest”).

For the percentage expressed, 100% is the total gains (externalities excluded). So the sum of all the full green line is equal to 100% (actually less because of rounding issues).

Report to **Appendix A** for details.

This figure indicates government currently exerts little influence on household's income so they are not in a position where they can dramatically influence them by modifying the way they distribute money.

Households actually mainly rely on their own assets: 51.4% of their gains are from their crops and 6.2% from their cattle (although cattle's costs make the activity unprofitable as a whole). Then the rest of their income comes from natural assets and they also benefit from great positive services not traded on the market from forest. So it may seem difficult to influence them because **they do not rely on income from other stakeholders**. But actually, **the State can exert a huge influence on them by regulating the use of natural assets or design economic incentives linked to them**. For instance, a ban on wild NTFP harvesting or a tax on their sales could be implemented (practical issues would surface though as it is complicated to enforce such measures: controlling access to the forest is barely possible and villagers can pretend they cultivated NTFP to escape the tax for instance).

As an indication, we also provide the average distribution of profits (flaws in the survey mean we do not always know whether people were reporting their income or their profit) reported by households during WCS Summer 2011 survey below.

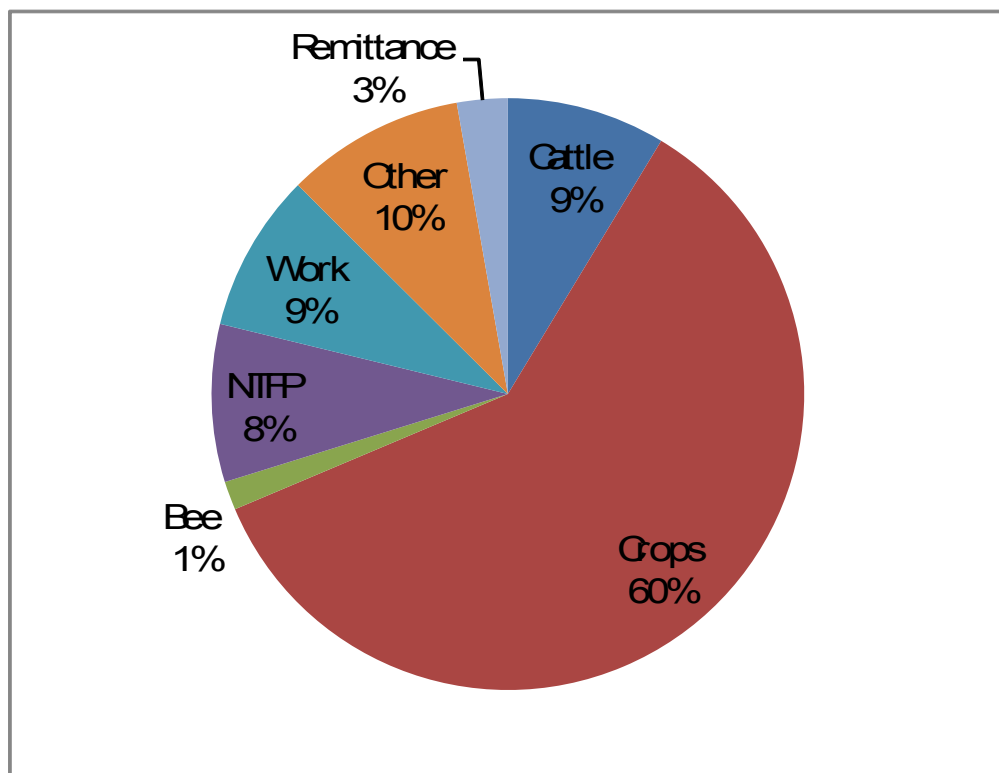


Figure 10- Profit break up by activity for the typical Hunchun household.

4. Special cases

The figures we displayed *supra* represent the average, typical, household but some households really differ from others and do not correspond at all to these figures (especially for their reliance on income sources). We quickly deal with them here.

Some **elderly people** are too old to work and they mainly or only rely on *remittances* (the term is used broadly here and include gifts from children in the same village) to survive. They typically live with really scarce resources and do not represent a concern for conservation objectives.

Frog breeders also really differ from other households as they can earn a lot of money from their frog farms. It implies their dependency on their **own assets** and **forest** (because of its positive externalities) sources is even more substantial than other households.

Finally, in **villages where NGO's projects are implemented**, households present an additional reliance on a new income source which corresponds to the NGO itself. That for instance happens in villages where WCS runs bee keeping programs. This additional reliance in theory means the NGO can exert some control on the households and try to change their behaviour.

IV. Classification of drivers in Hunchun

We will first use data we described in the previous **III** section and determine sector by sector to which categories of our typology it belongs. To characterize their opportunity cost, we will define case by case the appropriate *future activity* that would be more tiger-friendly. After the description of all the activity sectors, we will sum up the classification with charts that help to answer two of the main research questions we are seeking to answer about the characteristics of activity sectors that threaten biodiversity and about the possibility to improve these activity sectors only with economic incentives.

A. Caveat: the polyculture structure

As we have shown in the section **III.C. The typical household model**, most Hunchun rural households present a very diverse income base. They are characterised by a polyculture structure where their activities organize around their multiple cultures (corn, soya, sometimes rice, garden vegetable, etc.) and are complementary and diversified to spread the risks. It is not possible to separate the different effects or **more exactly they are not separated in reality**. Everything possesses its logic and is inserted in a coherent farm system: corn straw is eaten by cattle; farmers do not spend much time for their cattle because common or State forest pastures are available easily and the main activity - crops - require more time; one of the reason soya is cultivated even though corn can earn more money (when not destroyed) is that wild boars do not devastate soya fields (unlike corn fields) , etc.

In this section we separate activities in a simplification effort. Not doing so would be more appropriate but would make the analysis too complicated. We however have to keep in mind that there are links between activities: without crops, cattle husbandry would not be possible, and without cattle husbandry, farmers would not farm their fields the same way.

B. Decision rules for the typology

Regarding the typologies we defined in the **II. Typology of drivers and incentives**, when do we

consider profits are low or costs high ? When do we consider opportunity costs low ? We provide some guidelines here.

We compare the opportunity costs not to the profits but to the yearly costs of the activity. It indeed does not make particular sense to compare opportunity costs with what was used to calculate them (they are the comparison of the profits of the current and the future activities), though we could also compare the opportunity costs to the profits. But it can make more sense to determine how the shortfall opportunity costs represent compare with what the activity has to spend every year. Indeed, if an activity earn a high profits and have low costs, to reach the point when its owner will not be willing to switch to a *future activity*, it is not necessary to cancel the profit and we can imagine that just doubling their costs (opportunity costs equal to yearly costs) will make them refuse to forfeit their *current activity*, even though they would still earn a lot of money.

Table 15- Decision rules to classify drivers into one or another of the categories.

	Negative	Low	High
Profits	NA	Strictly less than 10,000 RMB	10,000 RMB and above
Costs	NA	Strictly less than 3000 RMB	3000 RMB and above
Opportunity costs	All negative opportunity not costs	Less than the annual costs of the activity	More than the annual costs of the activity

When we characterize activities, we describe a “***Future activity considered***” which, in accordance with the definition we gave for *future activity* in the “**Chap 2. II. C. 2. Opportunity cost to change to more biodiversity friendly practices**”, stands for a *compatible* alternative to the current activity. That corresponds to the activity we will compare to the current one to calculate the opportunity costs.

C. Cattle husbandry

Cattle husbandry is the activity we studied the most. It is interesting because (1) it presents **negative impacts** on our *reference objective* (restoration of tigers population and their habitats), (2) it is **not very profitable** and (3) it benefits from **support from society** that allows it to stay afloat. It possesses all the characteristics of an adversary of biodiversity that economic valuation can help to question.

We distinguish four possible forms for this driver:

- (A) husbandry **with forest pastures and with compensations**: the current situation in most places.
- 2 hypothetical situations that will allow us to analyse the role of support from society:
 - (B) husbandry **with forest pastures and without compensation**: we need to compare situation (A) and (B) to determine if compensations act as perverse incentives that increase the pressures on biodiversity
 - (C) husbandry **without forest pasture and without compensation**: to analyse the effect of pastures, we need to compare (B) (or directly (A))and (C)
- (D) **stall-feeding** which seems likely to become more and more frequent in Hunchun

Some other forms of cattle husbandry may be possible but we do not characterize them. We know that the Korean firm Tianyi (天一) owns large pastures far from the forests, if cattle are raised there from birth to their sale, husbandry becomes *compatible* with the *reference objective* of tiger restoration. But, unfortunately, such situations are likely to be rare in Hunchun (even Tianyi's pastures probably host cattle that were first raised in the forest and then sold to Tianyi at 12 months old). Another possibility we encountered in Hunchun involve pastures on the bank of rivers: as long as cattle do not graze in the forest, this kind of husbandry is *compatible* with the *reference objective*.

To further understand the form of cattle husbandry encountered in villages, it is worth knowing the limitations to produce more (ie to own more heads of cattle). After discussions with farmers, several **limiting factors** were identified: pastures size, quantity of straw produced and the resources they are willing to put into the activity. The cost of upgrading the cowshed to host more cattle does not represent a problem. Here are some details about these limiting factors. **First** pastures: they are reportedly already over-grazed so we can barely imagine an increase of the total cattle stock without changes in the way it is raised (but concentration of the activity could happen, with fewer farmers and each of them raising more cattle). **Second** the quantity of straw, which production does not constitute a problem right now because if farmers do not produce enough to feed their cows, they can obtain some from their neighbours for free. But if more cattle were raised, it would become an issue and straw would have to be bought. **Third**, another major limiting factor is that farmers do not consider cattle husbandry as a primary activity. Many complain that they are losing money with their cows and figures from WCS Summer 2011 survey tend to vindicate them. The main activity of most farmers is crop production. So farmers are not willing to spend much time or money for cattle husbandry. It limits the possibility of expansion and specialisation. We can also note that risks are quite high for this business: many cattle die because of diseases, snares, tigers... Husbandry does not offer great prospects, quite the opposite: putting efforts into cattle may for instance be rewarded by a sudden severe loss if several cows die intoxicated by acorns, as happened to one villager interviewed.

There are reasons that explain why farmers keep engaging in livestock husbandry: it can provide a saving system (when one has money, he can buy cattle and when he needs money, he just sells some heads of cattle) and cattle can work on the field to provide traction for agricultural tools. Farmers also sometimes consider livestock husbandry as an easy (that does not ask many efforts and does not present many hurdles) income: common or State pastures are available for free and husbandry does not require much work so why not raising cattle ?

1. The additional issue of compensation

Does it worsen or improve the situation related to our reference objective ? How to assess the effects of compensation ? The first question is not easy to answer because of the answer to the second: many data, time and skills from the analyst are required. If we did not analyse compensation, it would however constitute a failure to analyse the incentives faced by and the consequences caused by cattle husbandry.

Compensation is supposed to mitigate human-wildlife conflicts by removing incentives for farmers to kill predators. The reasoning is that before compensation, farmers want to control predators population because predators kill their cattle; whereas after the implementation of compensation, they can accept loss because they are compensated. An additional effects would consist of less retaliatory killings because compensation would render loss fairer. However, no data prove these two points, in Hunchun as in the rest of the world (Nyhus et al. 2003; African Elephant Specialist Group (AFESG) Human-Elephant Conflict Working Group (HECWG) 2002). Data from

Italy even tend to point to the opposite (Boitani et al. 2010). Bulte & Rondeau (2005) demonstrated that from an economic perspective, compensation can be detrimental for conservation. We use what we wrote in a report for WCS to sum up their arguments here (Berger 2011). Those arguments are based on the fact that compensation actually increases the income of its recipients compared to the situation without compensation and is therefore a kind of agricultural subsidy. It shifts the profit differential in favour of the economic sector that receives the subsidy and should increase its activity. If this sector is detrimental for conservation, then compensation has a detrimental effect to conservation. It happens through three effects :

1. A subsidy to **agriculture** decreases the time spent **hunting** but it increases the cultivated area, which means less land is available for wildlife. If this decrease in wild area presents a greater negative impact on wildlife than the positive impact of less hunting, then compensation is harmful for conservation.
2. Migration. Increased income in the compensation program area means less people leave and some may return or migrate to the area, increasing the activity of economic sectors detrimental to conservation.
3. Intensification of stocking rates and competition for forage with wild ungulates (once again because compensation corresponds to a subsidy to agriculture and therefore increases its activity).

When we consider our *reference objective*, an additional layer of analysis appears: compensations for damage on rice cultures by wild goose “consume” much of the compensations paid to farmers (about 2 millions RMB out of 3 millions RMB). Budgets for compensations are not unlimited and wild goose can potentially siphon them out entirely. It is worth noting that rice culture are seldom found in Chunhua town, close to where most tigers are likely to live. Thus, the compensation program's main focus are in reality not the tiger (even though it may have been the focus when it was created) or livestock husbandry.

Now that we have explained why compensation arguments for and against compensation, it would be interesting to determine its real effects in Hunchun and confront them to these arguments. However, assessing compensation presents many difficulties. Here are some methods we could use:

- **draw the curbs of offer and demand** of cattle and observe the effect of a rise in price (which amounts to what compensation induces, see Rondeau & Bulte 2007) on the quantity of good (cattle) produced. Then we would link these quantified increase of rearing of cattle with conservation. But data to draw these curbs are unavailable.
- **use a Computable General Equilibrium (CGE) model** as in Fortuna et al. (2011) to simulate the effect of compensation on the economy. The CGE model can predict variations in consumption and production in different sectors of the economy, unemployment, etc... It however requires a Social Accounting Matrix (SAM) that characterizes the links between sectors and the their own characteristics. Such data are unavailable in Hunchun.
- **use field survey data to assess the importance of compensation on households' income**: we can try to assess the proportion of households that would suffer negative cash flows for their livestock husbandry activity without compensation. This can be evaluated based on field survey data . We already have detailed: **(1)** the gains farmers can expect, **(2)** the mean loss caused by tigers per household and year and **(3)** the other costs (really paid by farmers and the opportunity costs that reduce the profit of livestock husbandry) in the **III. Analytical accountancy of the drivers**.

Even though it is not the best solution, we are forced to use the last option we described because of data constraints. We sum up the results we obtained in **III. Analytical accountancy of the drivers (in this Chapter)** below.

We calculated that livestock husbandry's profits are negative with our *more realist assumptions*. We demonstrated that **the compensations in average received by households are never high enough to tip the loss back into positive profit**.

But the situation may be different from year to year and from household to household. Every year, 2 out of 1000 heads of cattle are killed by tigers on average so we calculated that the average loss - and thus the average compensation - is 7.84 RMB/head and year²⁰. However, when a loss does occur, the real loss lies actually closer to 5000 RMB/head (or less if it's a calf or cattle that has not yet reached its full size). Receiving a 5000 RMB compensation when your annual result is minus 2000 RMB represents quite a windfall ! We met a farmer who explicitly said he felt happy when his cattle were eaten by tigers because he could receive a compensation which represented a significant improvement compared to when cattle died for other reasons. Indeed, cattle that presented a 12.8% (13% minus the 0.2% of cattle killed by tigers) chance to die for natural reasons and make no money can earn farmers some money thanks to compensations ! But in average, this additional revenue should still be only 7.84 RMB per head and year, which is not sufficient to transform the average result from a loss into a profit.

However, areas with superior attack rates may face a different situation; they benefit more from compensation. **The minimum rate of kills to make livestock husbandry profitable is 5%** or 5 out of 100 heads of cattle killed every year (according to the assumptions we described as *more realist* in the **III. Analytical accountancy of the drivers** and 5% represents the tipping point where profit becomes null, above 5%, profit exceeds 0).

2. Characterisation

a. Husbandry with forest pastures and with compensations

We described this predominant model of cattle husbandry in the **III. Analytical accountancy of the drivers**. We base our characterisation on figures obtained with the *more realist* assumptions.

Profits : negative profits*

Costs : low costs

Compatibility status : incompatible

Future activity considered: "no husbandry" which presents a negative opportunity cost as profits for cattle husbandry are negative.

The alternative "husbandry with preventive activities" is not *compatible* with the *reference objective* and cannot be considered. Farmers would have to guard cattle during the day, bring them back at night either in a fence they would have to build, or close to the village. Although it is likely to reduce tiger attacks on cattle (if fences are high enough so that tigers cannot jump above them), additional guarding of cattle would have negative effects on wildlife because the additional human presence would disturb wild animals, including wild ungulates that form tiger's preys. We can

²⁰ These figures are based on data from the Compensation Bureau. Based on these figures, we can calculate the average compensation amount and it is 3920 RMB/head.

imagine that a "no-wildlife land" would appear (or increase in area) around pastures, reducing the hunting area available for tigers. What benefits of the "husbandry with preventive activities" would balance this drawback ? Decreased attacks of tigers on cattle ? That does not constitute a benefit for tigers themselves. So preventive activities are not a solution to make husbandry *compatible* with tigers. The real solution would be to have pastures outside the forest but the opportunity costs would be too great as it would mean replacing arable land with grassland (and as we demonstrated it would not be profitable for individual farmers).

Opportunity costs compared to the future activity considered : negative

*: Why farmers keep pursuing an activity that lose money ? First, we have to remind our readers that apparent profits are positive and that is only when we take into account opportunity costs of soya and corn that real profits become negative. So they actually do earn money but they would make more money if they sold their corn and soya instead of feeding it to their cattle. Moreover, cattle husbandry provide farmers with other benefits :

- **traction** for field work : some of them do not have motorized tractors yet and some fields' geometry is not fit for tractors whereas cattle can enter them
- living **savings** :farmers pay (save money) every year to feed cattle which gains value every year (as interests) and then they can sell cattle if they suddenly need money (withdraw the money)

Farmers also benefit from free pastures and if they believe they can keep their animals alive until they sell them (one of the key assumption that explains why profits are still positive with *basic assumptions* and not with *more realist assumptions* is that with the former we assume a 0% rate of natural loss of cattle whereas we assume 13% die every year for any natural reason with the latter and it implies less cattle are sold, more are necessary to have a self sustainable herd and therefore costs are higher and earnings lower), then why not use these pastures ? The (transformation) costs are very low so they have almost everything to gain.

b. Husbandry with forest pastures and without compensations

Profits : negative profits

Costs : low costs

Compatibility status : incompatible

Future activity considered: same as a : "no husbandry"

Opportunity costs compared to the future activity considered : negative

We saw in the **III. Analytical accountancy of the drivers** that compensation in average does not present a significant effect on profits, so this alternative is equivalent to the situation with compensations.

c. Husbandry without forest pastures and without compensations

Profits : negative profits

Costs : high costs

Compatibility status : compatible

Future activity considered: same as a : "no husbandry"

Opportunity costs compared to the future activity considered : negative

Unlike compensations, free forest pastures have a key impact on the profitability and costs of livestock husbandry. We calculated in **III. Analytical accountancy of the drivers** the costs that farmers would have to pay to feed their cattle if they did not benefit no free pastures: costs would increase from "low" to "high".

In addition, the forest pastures are the sole cause of husbandry's incompatibility with the *reference objective*. Removing them therefore renders husbandry *compatible* with tigers's restoration. As farmers usually do not own or benefit from other large enough pastures, they will have to feed their cattle without interruption and their costs will soar.

d. Stall-feeding

Stall feeding consists in feeding cattle in big stalls with concentrated feeds and make them grow fast. Feeds are more costly than both free pastures (which are... free !) and feeds usually used by farmers in winter and quantities are also more abundant. Yearly costs are therefore greater (not to mention the initial investment to build the stall). Some breeds are fitter for stall feeding than others as they grow faster and can reach a superior weight. But in any case, they cannot start stall-feeding from birth: the first year will have to be spent outside and most likely in forest pastures. More money can be made from stall-feeding mainly because cattle are fatter and weight more when they are sold (and possibly because as cattle spend less time in the forest, there are fewer losses). Manure can also be sold for fertilization. Profits will thus be higher overall²¹.

There are different possibilities for stall-feeding with different starting age and time spent in the stall before slaughter. We assess the effect of stall-feeding on the number of animals in forest pastures and determine if it can present a beneficial impact for conservation (a drastic reduction of the number of animals in the forest could decrease diffuse competition with wild ungulates and provide more preys to tigers). We consider the situation of cows remains unchanged because they are still needed for reproduction and therefore cannot be stall-fed before the age of 60 months old: they will need to spend 5 summers in forest pastures. The number of births is also the same as the situation for cows is unchanged. So the only difference between traditional husbandry and stall-feeding concerns males and how much time they spend in forest pastures. **This depends only on when they start stall-feeding**; how long they are stall-fed has no influence. With the traditional husbandry method, males would spend 5 summers in forest pastures.

We describe two scenario for stall-feeding, both are possible but do not target the same breeds of cattle. The first one is quite beneficial to conservation and we call it the "*conservative*" *scenario*, the other one concerns breed with slow growth, we call it the "*slow*" *scenario*.

21 Banshi's people government (2011) estimates revenue of 10 000 RMB per head, feeding costs of 3000 RMB and they plan to buy 1 year old calf for 4000 RMB so the profit is at least 3000 RMB per head. But we consider farmers who already have calves so profit per head is 7000 RMB for them. Farmers are likely to take greater care of their cattle as its value is greater so the loss rate should decrease and they should be able to sell more than one head of cattle per year, making a profit greater than 10 000RMB/year: the activity can be considered as "high profits".

In the *conservative scenario*, cattle first needs to reach the age of 12 months old which imply it will spend a summer in forest pastures for villages which possess such pastures. Then it will spend 6 months in the stall and be sold at 18 months old. The male therefore spends only 1 summer in forest pastures instead of 5 and the **reduction of the number of cattle in the forest represents 40%** (80% less males but they represent only half of the herd size, the other half being females).

In the *slow scenario*, as is the case for the Yanbian Yellow Cow breed (which is very common in Hunchun area), the growth is too slow and cattle can start stall feeding only around 3 years old which greatly reduces the benefits of stall feeding: the **reduction of the number of cattle in the forest represents only 20%**.

Prins (2000) conducted a review of studies in Africa about cattle and wild ungulates interactions. Its findings highlight a **diffuse competition** between the two groups of animals (for instance through diseases) but **no direct competition** for food. So cattle presence could diffusely act on several groups of ungulates. But Prins suggests that the main issue for wild ungulates is associated with **human presence**. High density of cattle only presents a low impact on the density of wild ungulates as long as it is not associated with intensive human presence. But as soon as human presence starts to increase in the area, wild ungulates density plunges. This is very interesting to assess the effect of stall feeding: **a 20% or even a 40% decrease of cattle number in the forest may not translate into significant impacts** on wild ungulates, especially if farmers continue to go watch their cattle as often as before (to monitor 10 or 20 heads of cattle does not change how often you go monitoring and this frequency of journeys to the forest determines the impact on wildlife). Therefore, we consider stall-feeding to be *incompatible* with tiger restoration.

Profits : high profits

Costs : high costs

Compatibility status : incompatible

Future activity considered: same as a : "no husbandry". But here the profits is not negative so the opportunity costs, equal to the profits minus a zero profit for the *future activity* are high.

Opportunity costs compared to the future activity considered : high

C. Crop production

As we described in **II. C. Typical household model**, crops constitute the main revenue of the average household. They are the main activity and require the most time. We are not perfectly clear with the property rights for farmers as they did not represent the focus of our work and we did not study them in depth but it seems that three main types of cultivated land exist:

- **cleared fallow lands** (开荒地): some fallow lands (that were cultivated years before but had been forsaken) can be cleared by whoever wants them and that person can then cultivate them more or less legally. To my understanding, that person can receive compensation for damage to these lands (eg by wild boars).
- **lands leased to farmers for 99 years**: private property does not exist for agricultural land in China and the government leases land for a very long time to farmers. But everything happens as though farmers owned property rights on this land.

- **lands leased on a yearly basis:** villagers can conclude contracts to rent their lands to other villagers who will farm them and pay a annual fee to the "owner".

We have to stress that forests cannot legally be cleared to extend cultivated area. Severe changes to forest areas (such as important cuts to obtain construction wood) need authorization from Hunchun Municipal Forestry Bureau (the Government administration that deals with forest affairs)²². Fallow lands are not forest lands but for instance brush lands that were cultivated before. However, some authorizations are given to cultivate ginseng on forest lands that are cleared but have to be replanted after ginseng exploitation is finished (a matter of years).

So one **limitation** on total crop production is that the total area available cannot increase. It is limited and cannot be extended (not by clearing forests anyway). At the individual level though, farmers could use more inputs or buy lands from others to specialize themselves into crop production.

To restore tiger habitats, corridors through which the tigers can move from one uninhabited area to the other should be available (not to mention uninhabited areas themselves, preferably forests). Currently, large swathes of lands are covered with fields which may hinder tigers' moves. We thus classify crop production as *incompatible*, even though some level of crop production is *compatible* with the *reference objective*, ie only fields in the corridor areas are *incompatible*. In a way, we can talk of a *negotiable compatibility* for crop production: if farmers accept to stop growing crops in the corridor areas, they can “negotiate” their way to compatibility.

In the past, farmers had to pay taxes to the State to grow crops. Now the State subsidizes them (it provides them with 1200 RMB/ha, see **III. Analytical accountancy of the drivers**). Policies have changed and so have their aims. However, it is not clear if it has really modified the effects of economic incentives on crop production. The taxes were low and the subsidies only represent about 12% of the revenue per ha (but 20% of the profit). So profits may have been already high before, even with taxes instead of subsidies.

Profits : high profits

Costs : high costs

Compatibility status : incompatible

Future activity considered: “stop cultivation” if fields are located in a key corridor area. An alternative activity that comes to mind consists in transforming the fields into pastures and renting them to cattle owners. However, cattle husbandry is also *incompatible* with tigers moves for two reasons: first, husbandry is associated with human disturbances and second, if fences are constructed to park cattle, it will directly hamper tigers' freedom to move (additionally cattle can be killed by tigers that transit through the pastures which could deteriorate attitudes of farmers toward tigers). This alternative is thus not possible and the *future activity* has to be “stop cultivating”²³.

We have to note again that crop production do not need to stop everywhere, but only in key corridor areas. Consequently, some farmers will suffer high opportunity costs whereas other will not suffer any opportunity cost.

Opportunity costs compared to the future activity considered : high

²² 唐继荣 (Tang Jirong, WCS), personal communication (2011).

²³ Some extensive, low intensity, farming methods may allow tigers to move but we lack ecological and agronomic knowledge about them.

D. Frog breeding

Frog breeding generally features a high profit and is pursued by some well-connected villagers (it is necessary to receive authorizations from two departments of the Hunchun's government to run such farms) who possess enough money for the (high) initial investment. Although in some cases it may be pursued at a low scale with relatively low profits, people owning frog farms reportedly earn more than 100,000 RMB a year. That has been confirmed by the few such people we met during WCS Summer 2011 survey (and the head of the communist party of one village I went to alone, which himself owned a frog farm). Frog farms breed frogs in rivers located in small valleys deep inside the forest. Frogs' ovules are sold at a high price, making the activity highly profitable with low costs (Quach et al. 2010). Small frog farms may not be guarded for most of the year and their environmental impacts should remain low. Bigger frog farms are different though: they are kept by guards who can get really bored alone in the forest with nothing to do. It can lead them to raise dogs (which disturbs wildlife) and they are likely to poach. The location of frog farms inside rivers amplifies the disturbance they cause because riverine forests are the preferred habitat of tigers and in the absence of disturbance, these forests are also likely to host abundant preys (D. Miquelle et al. 1999). These farms are thus *incompatible* with our *reference objective*.

Almost 50% of frog farming activity is concentrated in Chunhua town: according to Hunchun's Government (2009), the output in Hunchun area stands at 11,260,000 RMB, of which 4,540,000 RMB are produced in Chunhua town. Very few data are available about frog farming environmental impacts but these figures suggest that if there is an impact, it would be important in Chunhua, which just so happens to be one of the places where the tigers are the most present.

Profits : high profits

Costs : low costs

Compatibility status : incompatible

Future activity considered: "scaled back, unguarded frog breeding". Without guards close to the farms, the impact of frog farming becomes very low and should be compatible with tiger restoration. But the profits would become meagre (because the activity would be scaled back) and the opportunity cost is consequently high.

Opportunity costs compared to the future activity considered : high

E. Forest exploitation

In some places such as the Amazonia, deforestation constitutes a major driver that threatens biodiversity (see for instance Taravella 2008, for an analysis of the pioneer front through the SEMA framework), but Hunchun is different. There, forest exploitation is controlled and it is forbidden to cut the forest without explicit authorization from Hunchun Municipal Forest Bureau (琿春市林业局). Exceptions concern firewood and other small wood for village uses. But if villagers want wood for construction or to craft home furnitures, they need an approval from the Bureau. Forest is still exploited but only in "forest farms" run by Hunchun Forest Bureau (琿春林业局) that needs to be distinguished from the Municipal Bureau. The former is actually a State company that manages forest exploitation whereas the latter is a government administration that regulates forest-related affairs. The State company employs more than a thousand employees and must find money to pay

them and their pensions so it still cut trees and sell timber.²⁴ Exploitation occurs in parallel with plantation of new trees and participates in a forest management planning. China national policy clearly aims to increase the forested area to fight erosion so we can assume the forest management is as sustainable as WCS believes, we therefore classify this activity as *compatible* with tiger restoration.

As a consequence, we do not really pay attention to its profits and costs because it is not necessary to oppose or change this activity sector. A very rough analysis however points to high profits and costs. There is no *future activity* and thus no opportunity cost because the activity is *compatible*.

Profits : high profits

Costs : high costs

Compatibility status : compatible

Future activity considered: NA

Opportunity costs compared to the future activity considered : NA

F. Bee keeping

Hunchun's climate is not perfectly fit for bee keeping because winter are often harsh and bees may die because of the cold, still some villagers keep bees and sell their honey. We will analyse it later in the **Chapter 4** but we can already note WCS has launched a bee keeping program with a basic idea: financially support farmers so that they raise bees in exchange of actions in favour of the tigers (mainly patrols to remove snares). Volunteers for WCS's Hunchun office studied honey profitability before the program was launched. They calculated a yearly profit of 500 RMB (Quach et al. 2010). It is likely to be very underestimated as we discovered other important underestimation in this report and in addition, inflation is severe in Hunchun so the profits are likely to have dramatically increased until 2011. In WCS Summer 2011 survey, 4 households keeping bees were interviewed and enjoyed profits of 650 RMB, 5000 RMB, 15,000 RMB and 30,000 RMB with a 12,788 RMB average profit. The 15,000 RMB profit household is specialized in bee keeping and enjoy no other revenue whereas the 30,000 RMB one presents a total income of 72,500 RMB, the two other significant activities being crops (40,000 RMB) and Non Timber Forest Products (NTFP) harvesting (2500 RMB). Profits for bee keeping can therefore reach substantial amount when the household is specialized, they are otherwise likely to be low. For our analysis, it is not very important to know if they are low or high since the activity is *compatible* with tiger recovery. Bee boxes are indeed set just in front of the villager's house so they do not cause disturbances for tigers. Wood needed to build the boxes can be obtained from the relatively sustainable and compatible villager's usual sources. Costs are low after the initial investment to buy boxes and bees, though bees may die in great numbers during winters.

Profits : low profits

Costs : low costs

24 唐继荣 (Tang Jirong, WCS), personal communication (2011).

Compatibility status: compatible

Future activity considered: NA

Opportunity costs compared to the future activity considered : NA

G. Non Timber Forest Product harvesting

Villagers complement their income by collecting wild NTFP in forest hills near their home or sometimes some dozens of kilometres away from their village (some reported going 50 km away). They collect ferns (called 薇菜) and mushrooms in spring when they are not busy with crops, and then mushrooms again in autumn. Costs remain low since the only inputs needed are time and, in some cases, oil to drive the vehicles if the collection takes place far away from the village. According to WCS Summer 2011 survey, profits are also low in average (3269 RMB) even though three households manage to earn 10,000 RMB or more (one household earns 15,000 RMB).

To collect NTFP, villagers enter the forest. It thus by nature constitutes an activity that disturbs wildlife (a low risk to encounter a tiger also exists and could lead to villagers being hurt or killed, which would negatively affect people's attitudes toward tigers). It presents an (unquantified) adversarial effect on the survival of tigers and the activity is therefore *incompatible* with the *reference objective*.

NTFP can also be cultivated by villagers but their sell price will be lower. I visited one village that cultivates Jew Ears mushrooms (木耳) and makes good profits. It however requires skills and organization : for Jew Ear and other mushrooms small plots need to be made in great quantities with wood sawdust (the mushrooms are grown on them), then an irrigation system must be implemented.

Profits : low profits

Costs : low costs

Compatibility status : incompatible

Future activity considered: cultivate all the NTFP that can be cultivated instead of collecting them and stop collection altogether.

Costs will depend on the scale of the cultivation but should be low if villagers maintain the same (low) earnings as before.

Opportunity costs compared to the future activity considered : low

H. Poaching

As we explained in **Chapter 1**, all forms of hunting are prohibited in Jilin province. This is not the case in other provinces such as Heilongjiang where wild boars can be hunted for example. All types of guns are also prohibited in Jilin province. This seems to be well enforced and I never saw or heard of any gun during my field work. As a consequence, illegal poachers need to use rudimentary metal snares to catch their preys : wild boars and deer mainly (we will deal with a possible tiger poaching later). This method is cheap (a reported cost of 1 RMB per snare in Quach et al. 2010) but not efficient : snares are set mostly in winter when poachers can track animal trails in the snow and then set the snares in narrow passages animals always follow, but they rarely catch

anything so a lot of snares have to be set. But as winter forms the dead season in Hunchun with nothing much to do, this inefficiency of snares does not constitute a trouble : poachers can set many snares, it does not eat on their productive time.

1. Poaching of tigers's preys

We assume profits remain in average low as the catches are rare. Quach et al. (2010) reports a price for a deer's head of 2000 RMB but we were unable to check such a number, if this is true, and as it is likely that poachers catch at least one deer during winter., and as they will not only sell its head but also other parts, then their profit is actually greater than 3000 RMB and we should consider it high. Let us recall why we study profits and costs in the first place : we want to know the economic incentives households face when they choose which activity to pursue. Here, it is interesting to note several factors that go against poaching even if earnings were high : **first** it is illegal, so some people may not want to engage in poaching on moral grounds, and fines reduce profit (even though we are not sure the probability of being caught is high enough) and **second** it is hard to find a market for wild meat as restaurants are prohibited from selling it and awareness campaigns have succeeded : even Hunchun City government officially spoke out against wild meat consumption. However, drug trade is illegal all around the world but it has not disappeared insofar because profits also stand very high and the risk is worth taking. Is it the case in Hunchun for poaching ? Villagers report that poaching has now all but disappeared and maybe only 2-3 households still poach in each village. They may be lying as other villagers reported there are still many snares around pastures and cattle can get killed because of that. In the end, **we consider poaching profits are low** because catch are rare and market small. Some poachers keep poaching because they like the activity and they auto-consume the meat and not because they are faced with high economic incentives to poach. We may be wrong though and the profits may be high.

Low density of preys have been identified as one of the main threats to tigers (WCS Russia n.d., Dale Miquelle, WCS Russia Program Director, pers. com. 2011). Poaching of tiger's preys decrease this density and is in consequence *incompatible* with the restoration of tigers.

Profits : low profits

Costs : low costs

Compatibility status : incompatible

Future activity considered: “stop poaching” as it is strictly incompatible and no alternative activity that can be practised in winter has been thought of.

Opportunity costs compared to the future activity considered : low

2. Poaching of tigers

Tigers can be **directly** poached because they are involved in Chinese traditional medicines. In the past, it was a juicy market: 100 millions RMB (USD 12.6 millions) a year in the 1990s (Jenkins 2006, quoted by Nowell & Xu 2007). Now, the situation is more complicated as tigers are protected and Chinese medicines based on tiger parts have been removed from China's official pharmacopoeia. The market has become illegal and demand has dropped. TRAFFIC's studies showed that tiger-based medicine such as tiger bone wine were hard to find in 2006: only some percentages of Chinese medicine shops were selling them and not in all cities (Nowell & Xu 2007).

Another potential product that can be derived from tigers are tiger skins which became very popular in Tibet after the 1990s and were worn as show off cloth. It became a significant threat as the market spread with a culmination in 2005 when pictures of Tibetan wearing such cloth during Tibetan festivals were revealed to the world (Nowell & Xu 2007). The situation has now considerably improved and though some tiger skins are still sold, the quantities have greatly decreased (Xu Ling, TRAFFIC, pers. com.). Actually, **incitations to poach tigers remain very high** because a single tiger represents a lot of money once poached: one gram of tiger bones sells at a wholesale price of 10 RMB and one can get 10 kg of bones from a single tigers, meaning a total earning of 100,000 RMB (to compare with an annual mean income of about 36,000 RMB in Hunchun according to WCS Summer 2011 Survey). Poachers are however likely to receive much less than that as it seems that intermediary traders capture the greatest share of the profits, buying tiger's parts for only a tiny fraction of the real price to poachers (poachers would receive only a thousandth of what traders get according to Noel 2000 and WPSI 2000 quoted by Damania & Studies 2001).

But we reckon that the main difference between the current situation and the situation of the 1990s lies in the fact that now almost no tiger remains left in the wild in China whereas the population in the 1990s allowed a considerable uptake:

“Chinese medicine industry representatives told Jenkins (2006) that: 'The annual removal of Tigers from the wild peaked in the 1960s at approximately 300 animals, yielding in the region of three metric tonnes of Tiger bone. The harvest rate declined from approximately 200 animals per annum in the 1970s to less than 100 animals per year in the 1980s. The decline in annual harvests reflected declining numbers of Tigers in the wild.'”

(Nowell & Xu 2007)

As a consequence, if Chinese traders wanted to use tigers from China to make Chinese medicines now, they would have to organize a complex, dangerous and costly supply chain to get only about 10 tigers and **then they would have to stop their activity** because there would be no more tiger left. This is not worth the cost. But we believe recovery of tiger populations in China would trigger a renewed trade of tiger Chinese medicines. Economic incentives are too high to believe it would not happen. However, Xu Ling from TRAFFIC East Asia expressed her personal belief in a personal communication and said she believed if tiger recovery succeeded, it would be because several important conditions (among them stakeholders willingness to protect tigers) would have been met and thanks to these conditions, there would be no more illegal tiger parts trade.

In Russia, demand for tiger parts for Chinese medicine remains still a fierce threat and according to Dale Miquelle, head of WCS Russia Program (pers. com. 2011), it represents the single greatest factor threatening tigers worldwide. Poaching accounted for more than 40% of tiger deaths in Russia between 1992 and 2005 and more than 30% of other deaths were suspected to be caused by poaching (WCS Russia n.d.). Poaching is quite obviously *incompatible* with our *reference objective*, even more so as we believe that recovery of tigers will allow poaching to start again.

Here is a helpful model to understand the microeconomic decision of poachers, retrieved from a report that examined the economics of demand and offer for tiger alive and dead - ie tiger medicine or other derivatives - (Broad & Damania 2009):

$$\text{Equation 1} - \Pi = (s - \theta_p \Omega_p) H_T - w_p L_p$$

The profit Π is equal to the earnings $(s - \theta_p \Omega_p)H_T$ with s the price of one tiger for a poacher, θ_p the probability of being caught and Ω_p the fine for poaching a tiger. w_p is the cost per unit of effort and L_p the level of effort. Tiger poaching happens in open access (because no one can be excluded from poaching), the economic rents are thus dissipated and poachers poach as much as they can until the profit is zero. From this equation, it is clear that the catch H_T would be null if the average fine $\theta_p \Omega_p$ cancelled the earning. According to the Chinese regulation, fines for illegally hunting protected species (the tiger being one of them) can be up to 10 times the value of the killed animal and only up to 10,000 RMB if no catch is found (中华人民共和国野生动物保护法 or Law of the People's Republic of China on the Protection of Wildlife, abbreviated **Law on the Protection of Wildlife** after [Seventh National People's Congress of the People's Republic of China 1988], and Regulations for the Implementation of the People's Republic of China on the Protection of Terrestrial Wildlife, abbreviated **China Wildlife Reg** after [China Ministry of Forestry 1992]). It means the probability of catching an illegal poacher must be very high: one out of ten times someone goes to poaching, he must be caught. It is likely that the fine is too low and the enforcement system not credible enough.

Following this analysis, we consider the profits of poaching to be high (extremely high actually) and the costs to be low. The activity may however not be pursued in Hunchun before the recovery of tiger populations. A big question mark remains regarding this issue because poaching is happening in Russia on a large scale and the market for the Russian tiger parts is obviously China so a smuggling pathway from Russia to China major cities must exist and, in theory, it could easily make a detour to take tiger parts from Hunchun. By the way, costs for the smugglers are likely to be higher than for poachers, so are their profits.

Profits : high profits

Costs : low costs

Compatibility status : incompatible

Future activity considered: “stop poaching”. If tigers population were much more considerable (for instance in the thousands individuals), some level of poaching might be acceptable and the costs for society to fight it may exceed the social costs of poaching. But with such a limited tiger population, poaching is totally *incompatible* and should be stopped.

Opportunity costs compared to the future activity considered : high

I. Road and railway building

This driver distinguishes itself from other because it is **directly government driven** and is more associated to politics. China promotes a pro-high speed train policy and is extending its network at a fast pace (at least it was the case before the Wenzhou high speed train collision in 2011). Dale Miquelle, director of WCS Russia program, mentioned in a personal communication (2011) a north-south high-speed railway project that would cut tigers' habitat. This represents a **major threat** to the *reference objective* because the largest population of tigers are located in Russia and the only hope to get tigers in Mongolia again (for instance) lies in Russian tigers migrating west. But with this railway, it will become very difficult for them to move west (or impossible if no adjustment to let wildlife cross the railway is implemented). In the same communication, D. Miquelle talked about a border fence on the Sino-Russian border that would present the same consequence. We will analyse

how economic valuation of biodiversity could be used regarding these projects in the **Chapter 3**.

To use the words of WCS Russia, “*Because they increase access for poachers, roads are another important threat to the Siberian tiger*” (WCS Russia n.d.). Although sample size are very low, Kerley et al. (2002) showed that roads impacted the survival rate of tigers (they argue the difference is significant but it is hard to affirm as some groups of the sample include only 2 individuals...). They recommend that construction of primary roads be stopped in protected area and use of secondary roads prohibited, otherwise these areas cannot work as source population. Sadly, their sound recommendations are not applied in Hunchun where roads and tracks in the National Reserve can still be used. Logically, we classify road and railway building as *incompatible* with the *reference objective*.

We do not possess data about profits associated with the roads and the railways and we also lack a methodology that satisfy ourselves to assess such profits (the application of “traditional evaluation methods” to evaluate benefits resulting from road building did not convince us in Mermet 2003). Which activities' profits must be considered (only the construction firms and the government or all activities that may be directly or indirectly impacted by the roads and the railways) ? To what situation must the profits during and after the road construction be compared ? What area can we consider to be impacted (only 100 m around the road or a whole region ?) ? The question of the system to consider is especially problematic. Mermet (2003) studied roads in the French Alps and Pyrenees mountains and answered some of these questions but another remains: how and where to get the data ? For his studies, data could be obtained from the ONF (the French National Forestry Office)'s road building plans. The ONF had submitted such plans to receive funds and to get approval from their customers (townships). In China, it would likely have been much more complicated and would maybe have asked a whole internship focused on the issue. We assume profits are high but actually many infrastructure projects (roads, dams for instance) do not create social value (Mermet 2003).

Costs are easier to assess: they are very high. An article from China's official news agency mentioned the cost of the 359 km long railway from Jilin city to Hunchun city: 41.6 billion RMB or about USD 6.9 billion (Xinhua Jilin 2010). Costs are very high because almost half the tracks are tunnels or bridges. According to the same source, 3600 km of new rails are planned to be built in Jilin province. We can imagine the costs and compare them to Hunchun total government expense in 2009: about 1.2 billion RMB (Hunchun's Government 2009). As a side note, Hunchun's environment spendings are of course inferior to this sum so it is obvious that they are dwarfed by the spendings on rail construction.

Profits : high profits

Costs : high costs

Compatibility status : incompatible

Future activity considered: “path adjustment”. The railway infrastructure can be adjusted to include animal passages (below or above the rails). It can also avoid crossing through some key zones for the tigers (for instance nature reserves). The costs of such measures is likely to be very high in absolute terms but very low compared to the total costs of the railway.

For roads, construction near or inside protected areas should be stopped (the opportunity cost for society as a whole may actually be low since these roads may benefit only to a few people and those benefits may not match their costs as showed by Mermet 2003). For other roads, it has to be

considered whether they are in an area where tigers live or will live and adjustments that may allow animals to cross the road without danger should be considered.

Opportunity costs compared to the future activity considered : high

J. Influence of perverse incentives/subsidies on the drivers

1. Definitions

The OECD defines (economic) *incentive* as “measures that make use of the price system and market forces to achieve their objectives” (Bagnoli 2003) and it defines *subsidy* in a broad definition to “comprise all measures that keep prices for consumers below market level or keep prices for producers above market level or that reduce costs for consumers and producers by giving direct or indirect support” (Barde & Honkatukia 2004). This definition of **subsidy** includes **compensation** for damage caused by wildlife to crops or livestock. Indeed, compensations reduce costs for producers as the costs associated to wildlife damage are reduced by the amount they receive as a compensation. It is worth noting that without compensation, the market price of crops or livestock in theory already internalizes the occurrence of losses caused by wildlife: the price in markets where wildlife damage occurs²⁵ is higher than it would be without these damages and the costs for farmers is already null, though they may have to adjust the quantity the produce to satisfy demand (see Rondeau & Bulte 2007 for a formal demonstration).

An additional definition useful for us is that of *harmful*, the OECD defines harmful in the case of subsidy: “encourages more environmental damage to take place than what would occur without the subsidy” (Bagnoli 2003). *Perverse incentives* are thus incentives that were designed for one goal but in the end presents unintended harmful consequences (this definition is broader than a more restrictive definition that would consider only incentives that have effects symmetrically opposite to what they were intended for). Are these incentives perverse because the incentive idea itself is imperfect ? Or is it the implementation that was flawed and triggered harmful consequences ? We will come back to this idea of an defective implementation responsible for the harmful effect in **Chapter 4**.

The definition of *harmful* is illustrated and extended thanks to a basic figure we reproduce below. The line D represents the demand (or marginal social benefit) for a given good or service. MSC is the marginal social cost (social cost for an additional unit produced) curve: to a given quantity of good or service produced is associated a given marginal social cost (eg a quantity Q^* means a marginal social cost of P^*), which includes both the private cost of the provider of the good or service and the cost for the rest of society (eg a polluting industry emit pollution for every unit of good it produces and this constitutes a cost for society as a whole, in addition to the industry's private cost). The intersection of the two curves forms the *social optimum*: producing a unit more would cost society more than what it gains and producing a unit less would mean costs are lower than benefits and so it would make sense to produce more. **At the social optimum, a quantity Q^* is produced.** However, the marginal private cost curve is MPC and **for individual provider of the good or service, it is optimal to produce a quantity Q_0** , this constitutes a *market failure* because markets should correct the private cost so that it equals the social cost. Further, if governments provide subsidies to produce the good or service, the private cost is reduced again and we can represent it by the curve MPC-SUBS. Obviously, **the new private optimum Q_1** is further still from Q^* , this constitutes a *policy failure*. Other forms of government support may be imagined

²⁵ It of course depends on the size of the market: if damage occurs locally but the price is international, then farmers' loss may not be internalized.

(such as a price guarantee P_2) and market and policy failure may not add up like in this example; we refer our reader to Barde & Honkatukia (2004) for additional details.

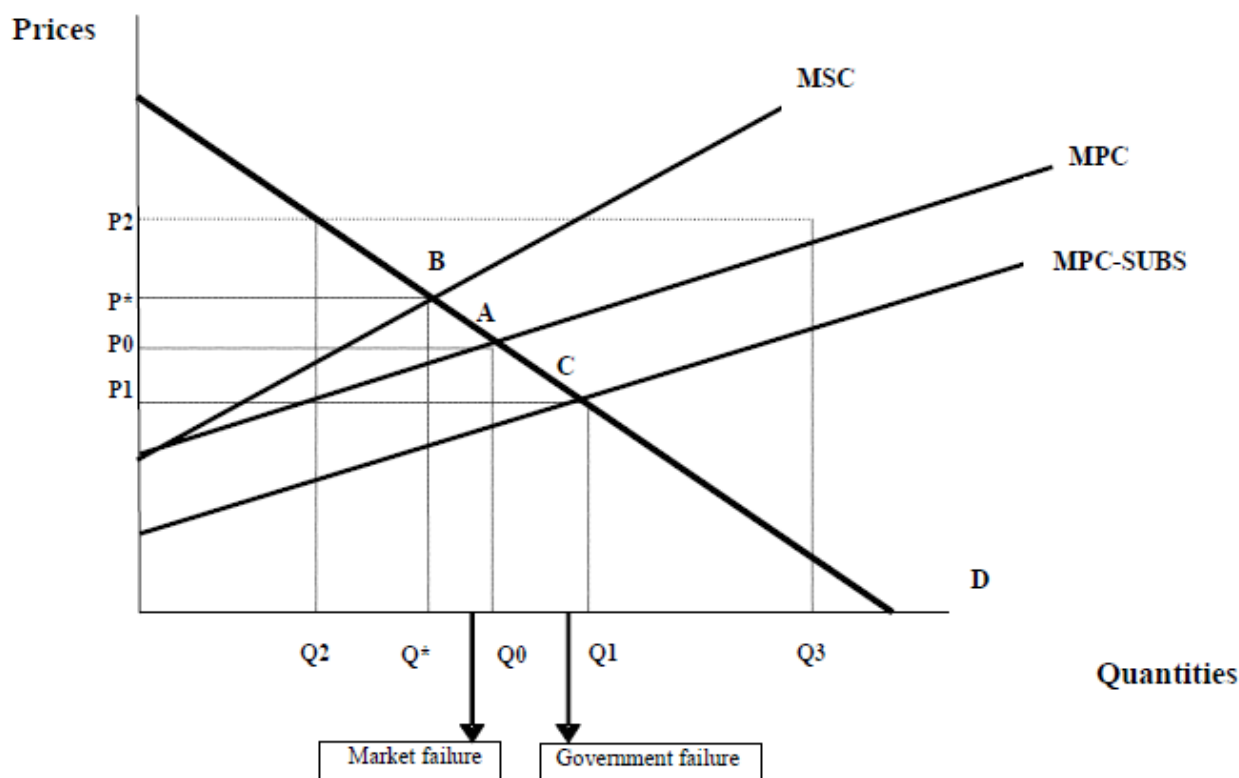


Figure 11- Market and government intervention failures (reproduced from Barde & Honkatukia 2004, p.4)

On the figure above, the subsidy is indeed *harmful* if damages to the environment increase with the quantity produced. But it is worth noting that (1) the private optimum with Q_1 produced is considered as the reference for the OECD definition of *harmful* (it is indeed what happens without government subsidies) and not the social optimum and (2) even with the social optimum, it is likely there will be some level of environmental damage as Q^* is not null (Godard 2001). If the social cost is not high enough, that could lead to serious degradation of the environment.

“You cannot manage what you do not measure” stated Pavan Sukhdev, study leader of the TEEB. Without entering the debate (we will deal with it in **Chapter 3 and 4**), we may add that we also have to measure it well or more exactly to have correct preferences related to environmental issues. For instance, if society considers losing an Amur Tiger does not entail such a loss, the marginal social cost of poaching remains very close to its marginal private cost which probably means that even with a socially optimum poaching of tigers, we would lead them to extinction.

2. Reasons to implement subsidies and why they can be harmful

Why do governments implement subsidies in the first place ? And why do they sometimes turn harmful for the environment ? The OECD provides some reasons explaining why governments put in place such support measures: “to enhance the competitiveness of certain products, processes, industries, or develop the employment and income of social groups or regions” (Barde & Honkatukia 2004). They can turn harmful for the environment because “In general, the full economic, financial, environmental and social costs of support measures are not considered, and on balance these costs may often outweigh the benefits of implementing the support measure, thus

leading to significant government intervention failures” (Barde & Honkatukia 2004). So according to the OECD, support measures are designed to serve specific groups' interests and they lead to harmful effects because they do not take into account the full social costs and reduce the private costs for goods or services production, leading to a production far from the socially optimal one: it's a government failure as described in the figure above. We quite agree with these answers but we would like to add that sometimes the full social costs are intentionally not (or not correctly) weighted by people in governments whose interest are aligned with sector-based actors (and thus are no more regulatory actor but can be considered as sector-based actors too, as is the case for the French ONF we mentioned before, cf Mermet 2003) because they know that if they did correctly weight the full social costs, their support measures would lose appeal.

3. Compensation for wildlife damage as an harmful incentive

The harmful subsidy literature usually does not consider compensations. Several arguments however show it can be detrimental for conservation and worsen situation and can thus rightly be called *harmful*. Some arguments of Bulte & Rondeau (2005) are based on the fact that compensation actually increases the income of its recipient compared to the situation without compensation and therefore amounts to a kind of agricultural subsidy²⁶. It shifts the profit differential in favour of the economic sector that receives the subsidy and should increase its activity. If this sector is harmful for conservation, then compensation features a detrimental effect to conservation. It happens through three effects:

1. A subsidy to **agriculture** decreases the time spent **hunting** but it increases the cultivated area, which means less land remains available for wildlife. If this decrease in wild area involves a greater negative impact on wildlife than the positive impact of reduced hunting, then compensation on balance damages conservation.
2. Migration. Increased income in the compensation program area means less people leave and some may return or migrate to the area, increasing the activity of economic sectors detrimental to conservation.
3. Intensification of stocking rates and competition for forage with wild ungulates (once again because compensation amounts to a subsidy to agriculture and therefore increases its activity).

The African Elephant Specialist Group (AFESG) Human-Elephant Conflict Working Group (HECWG), 2002, identified eight deficiencies of compensations. Five of them are practical issues and the three others show that compensation is a flawed concept. We cite the only one that tends to show an harmful effect of compensation (the other just tend to imply it is inefficient but not that it could worsen the situation): compensation reduces the incentive for self-defence by farmers. Self-defence measures would indeed increase their cost and would not bring them any additional profit since they are anyway compensated for their loss. Therefore compensation could even exacerbate the scale of the problem (through an aggravation of the losses undergone by farmers), which would both increase private costs before compensation and the costs for the taxpayer.

Moreover, as we noted, compensations can be considered as a subsidy in the broad OECD's definition we cited. So compensations indeed constitute *harmful* subsidies. However, our study tends to show that compensation is likely to hold little influence in Hunchun because tiger attacks

²⁶ The free medicines and vaccines provided by local governments to farmers represent another harmful public subsidy (we do not deal with it because of a lack of data). They clearly decrease costs for farmers who do not need to pay the vet any more (except for the medicines not included in the scheme) and it probably encourages them to increase their production compared to a situation without these policies.

on cattle remain relatively rare in Hunchun (see **III. Analytical accountancy of the drivers**). We do not mean compensation does not form a *perverse subsidy* - it indeed is a *perverse subsidy* - but in the case of Hunchun, it does not represent a major factor threatening tigers and decreasing social welfare.

4. Free forest pastures as an harmful incentive

Another form of support from society to farmers does involve a pronounced negative impact on tigers though. Pastures located in the forests can be grazed for free (even though we heard of fees in some village, Chin s. d.). These pastures are either State owned, in which case we can say that taxpayers support the farmers, or collectively owned, in which case it is the village that supports the farmers. In the collective ownership case, as many people in the village are raising cattle, it is less justified to consider that society supports the farmers, because in fact they more or less support themselves. But in the State ownership case, the State could clearly levy forest fees on farmers who use them. These fees could represent the marginal social cost of cattle husbandry and the **external effect** of cattle husbandry would be **internalized**. It would force farmers to stop engaging in livestock husbandry, or at least only the farmers who already produce social value, ie whose marginal (private) benefit outweighs their marginal social cost (that includes their private cost) would stay in the business and cattle husbandry would start producing social value. Can we talk of *harmful incentive* here ? If we compare the current situation with an hypothetical situation where taxes would be levied to use the forest pastures, the answer is “no” because it is an externality that causes the problem and the baseline is the current situation and does not exhibit harmful public policy related to pastures. But actually the **baseline** is not the current situation, it is a **situation where the use of forest pastures is forbidden**, and that actually corresponds to what requires the law inside the core zone of the Nature Reserve. So allowing farmers to use forests indeed constitutes an *incentive*, but not an economic one as it does not involve market forces or price systems, and it is indeed *harmful* as it worsens the situation compared to the baseline. Even though we just explained it does not constitute an economic incentive, it can still be modelled the same way as a subsidy on the figure 11 above: it reduces costs for farmers and their marginal private cost curve is shifted downward.

Free forest pastures thus establish an *harmful incentive* that deteriorates tigers' situation. Furthermore, in the core zone of the Nature Reserve, the law prohibits human activities and *a fortiori* grazing by livestock, but local authorities tolerate such grazing (see Chap. 2, III, A. Cattle husbandry). Free forest pastures therefore represent a *perverse harmful incentive* in the core zone of the Nature Reserve. They significantly support livestock husbandry and as a consequence significantly harm chances of tigers' restoration.

5. Crop production subsidies as an harmful incentive ?

We did not study into details crop subsidies but if land control is strictly applied (that is to say, farmers cannot cut forest to expand their land) as we have assumed and as our interviews tend to confirm, then crop subsidies are not likely to exhibit a harmful effect. In the opposite case, they are likely to trigger an increase in cultivated area and a specialization of farmers (Rondeau & Bulte 2007) that could in the end lead to a severe reduction of the available habitat for tigers.

K. Summary of the classification for all the drivers

We recognize our typology is quite blunt (eg not all crop production is incompatible with

restoration of tiger habitat) and a further more precise study must be conducted to prioritize targets environmental strategic actor have to try to act on first.

First, we would like to remind our reader that drivers are not passive, neutral forces that blindly threaten the environment. In the case of the Amazonian forest, deforestation is not a force moved by itself that inexorably cut trees, it is instead the result of incentives to cut trees, of an organization of society that does not stop it and of sector-based actors that do what they can to continue their activities even though they destroy the forest. In our thesis, we mainly present the incentives facing these sector-based actors - and the two following figures summarize our analysis - but we do not discuss much the organization of society and of the sector-based actors. Then, we also want to stress that drivers are not *synergistic*, *compatible* and *incompatible* by nature, they fall in one or the other of the category relatively to the *reference objective* defined by the analyst. This *reference objective*, as we explained in the **Methodology** needs to be useful to some of the stakeholders. In our case, the *reference objective* is the restoration of tigers population and habitat to their level about two centuries ago. But if the *reference objective* was just to reach a population of 20 tigers in Hunchun, then the **crop production** driver would not be incompatible for instance, because no migration corridor would be needed.

	Low costs	High costs
High profits	Windfall Frog breeding Poaching of tigers	Intensive Road and railway building Forest exploitation Crop growing Stall-feeding
Low profits	Auxiliary NTFP Bee keeping	Breadwinner
Negative profits	Market anomalies Husbandry w/ forest pastures & w/ compensation Husbandry w/ forest pastures & w/o compensation Husbandry w/o forest pastures & w/o compensation	

Figure 12- Hunchun's drivers' economic incentives (compatible drivers in green).

We identified one *market anomaly* in Hunchun: **cattle husbandry** which loses money at the household level. However, our analysis revealed that it is losing money because of the opportunity cost of feed given to cattle and not because of purchases households have to make, so the profits in appearance seem positive. We extrapolated our results and imagined what would be the situation **without compensation**: the activity would of course stay in the *market anomaly* category as profits would further decrease. We also imagined a situation **without free forest pastures**: there would be a change as costs would soar because of the additional feed farmers would have to provide to cattle: the activity would still be a *market anomaly* but would move to the right, below the “high cost” header. Cattle husbandry's *market anomaly* becomes *intensive* if it is intensified into **stall feeding**. It

may represent a good news for the GDP (more profits mean a higher GDP) but as **stall feeding** remains not *compatible* with the *reference objective*, it does not represent one for strategic environmental actors. We indeed explained in our **Chap.2, II., C., 4. Use of the typology** that it is not possible to argue that *intensive activities* lose money (they indeed earn a lot of money). So strategic environmental actors loses one possibility of advocacy against livestock husbandry.

The figure also illustrates the variety of types of drivers threatening biodiversity (all the ones in white): they can be *market anomaly*, *auxiliaries*, *windfalls* and *intensive*. We did not find examples of *breadwinner* but it is likely that examples can be found in other cases of environment problems. This first classification is mainly useful to oppose *market anomalies*: strategic environmental actors can use our analysis to oppose **cattle husbandry** (which is *incompatible*) by encouraging other stakeholders to stop supporting it; but to go further, we need to have a look at the figure below, which illustrates the second type of utilisation we described for our typology: as a technical tool.

		Compatibility with the restoration of tigers		
		Syn.	Compatible	Incompatible
Opportunity cost	High			Road and railway building Poaching of tigers Frog breeding Crop growing Stall-feeding
	Low		Forest exploitation Bee keeping	Poaching of tiger's preys NTFP
	Negative			Husbandry w/ forest pastures & w/ compensation Husbandry w/ forest pastures & w/o compensation Husbandry w/o forest pastures & w/o compensation

Figure 13- Hunchun's drivers' technical classification to determine if and how to act on them.

We described the implications of the different combination of opportunity costs and compatibility with the *reference objective* in the **II. B. 4. b. Technical tool**, here we offer an application of this typology.

Forest exploitation and **bee keeping** are *compatible* they thus do not need to be changed to reach the *reference objective*. All other drivers are *incompatible* and need to be changed.

For **traditional cattle husbandry**, it should in theory be easy: information and technical support should be enough because the opportunity cost to stop the activity (we defined “no activity” as the *future activity*) is negative. However, the strategic environmental actor we know the most, WCS, has not fully realized cattle husbandry is *incompatible* with the restoration of tigers and their actions try to support it instead of opposing it (see **Chapter 4**). Some farmers are aware cattle husbandry loses money and they already stopped or plan to stop. However, *perverse incentives* (see the previous **section, J**) from the local, provincial and national governments such as compensation, free State and collective pastures and stall-feeding schemes as in the town of Banshi, encourage farmers to continue keeping cattle or even to intensify their activities. Without these incentives, cattle husbandry may actually disappear by itself. To deepen the analysis, we can try to distinguish between elements that are by essence *incompatible* and those which can become *compatible*, we can call them elements presenting a *negotiable incompatibility*. Unfortunately for cattle husbandry, no such negotiable incompatibility exists because the incompatibility stems from forest pastures and in almost all places, no replacement option is available: the lands that remain not cultivated are either forested or built.

NFTP harvesting and **poaching of tiger's preys** enjoy low opportunity costs so it should be possible to devise schemes using economic incentives to prevent people from pursuing these activities. PES may not be really fit because one can hardly monitor if people do not harvest or do not poach (whereas for deforestation, you can more visibly see - sometimes using satellites - if people cut trees or not). But alternative activities that can earn people an income and consume all their available time should be possible to implement. In **Chapter 5**, we review such a scheme, which failed because the idea was actually flawed: a WCS's **bee keeping** scheme.

Finally, drivers such as **roads and railways building**, **poaching of tigers**, **frog farming**, **crop production** and **stall feeding** are *incompatible* and have high opportunity costs. They are in theory the most difficult to oppose because their profits would shrink if they turned to the more environment-friendly *future activities* we defined. These drivers are no less important than other (and may actually be more important, at least for roads and railways and poaching of tigers) related to the recovery of tigers. Our analysis thus shows that statement such as the one reproduced below are far too optimistic:

“rudimentary estimates suggest that the sums needed to shift incentives towards conservation would not be large as most inhabitants in tiger habitats subsist at low levels of income. Missing is the political will, economic expertise and fiscal resources to pilot such schemes.”

(Broad & Damania 2009)

The political will may indeed be missing for most of the drivers but probably not to stop poaching since all regulations strictly prohibit it. But in any case, fiscal resources would not solve problems caused by the other *high opportunity cost* drivers or really huge amounts of money would have to be spent. And even though most inhabitants in Hunchun's area do indeed subsist at low levels of income, it does not mean **(1)** that all do, at the opposite some earn a lot of money, **(2)** that all activities present low-profit, low opportunity cost to change.

We did not identify *synergistic* drivers (partly because we focused on adversaries of biodiversity and we did not put as much efforts on the study of activities that involved no adverse effects on tigers). Example of *synergistic* drivers can be found elsewhere though: for instance if we consider a *reference objective* of maintaining beautiful open landscape in the Alps mountains in France, then extensive grazing of mountain pastures by sheep flocks is *synergistic*.

We classified activity sectors in order to determine how one can act to change or oppose them to protect the tigers and allow their reconquest of their habitats and population. Activity sectors threatening tigers are very diverse and a single tool cannot fix them all. Without going too far on a debate we will lead in **Chapter 4**, it appears that some activity sectors present high opportunity costs to become more tiger-friendly (eg roads and railways construction), so economic incentives alone cannot push them to change (or either huge financial means would be necessary or one would have to focus on influencing a limited numbers of agents) and regulation tools are probably necessary. But who will implement new economic incentives or regulations more favourable to tigers ? And why would he modify the current *status quo* ? Our analysis will probably help strategic environmental actors who already desire to act on the situation but sector-based actors will probably not change their activities just because we tell them they are *incompatible* with an environmental objective, nor would they change if we affirmed reaching this objective has a social value for society, which corresponds what economic analysis of biodiversity can do (see **Chapter 3**). Or would they ?

To really be able to change the drivers, it is also necessary to alter the organization that allows them to persist. The resources for the struggle for change need to be conquered by strategic environmental actors: financial power, regulation power and media power (Godard 1993).

V. Chapter conclusion: our method contribution and strategic insights

Our method contribution

In this chapter, we obtained two major results: first, we demonstrated that forest pastures play a major and harmful role that keeps afloat a *market anomaly*: livestock husbandry. Without these free State or common pastures, livestock husbandry's profits would plunge. We also proved that compensation does not, in average, constitute a significant perverse subsidy, though it may play a more noteworthy role if losses caused by tigers reach 5% (at this rate and with the *more realist assumptions* that we defined, it would increase the profit of livestock husbandry up to 0 which would almost make it profitable again). This situation may happen in some localised areas but is not common (the average rate of loss is 0.2%).

How did our method produce these results ? The first result is quite intuitive: cattle spend the majority of their time of the year in free pastures and it surely considerably helps farmers. But we were able to quantify this and demonstrate that it represents a major factor to the continuation of the activity. The second result, about compensation, is not intuitive. We were able to obtain it because we defined a conservation objective and the conditions to reach it, we methodically listed all the incentives faced by households and the activities associated with them (guided by our *dashboard*), and we then determined if activity sectors were compatible or not with these conditions. At this point, we were able to figure out which incentives are *harmful* or even *perverse*: they correspond to incentives

related to *incompatible* drivers and that further encourage their expansion. We collected data about incentives related to livestock husbandry and were as exhaustive as possible to finally quantify the effect of *harmful* incentives. These steps of: (1) definition of the environmental problem, of an objective and the required conditions to reach it, (2) identification of: drivers, the ones that are incompatible with the objective, the incentives they face and the ones that are harmful and (3) collection of data to quantify and prioritize incentives and (4) analytical accountancy, are mandatory to reach results similar to ours.

Strategic insights

As long as it involves pastures in the forests, livestock husbandry is *incompatible* with the reference objective of the restoration of tigers' habitats and populations. As a consequence, all livestock husbandry methods are *incompatible* except those that involve pastures in the banks of rivers or the vast Tianyi's pasture. But currently, WCS is studying the possibility to support stall-feeding programs (and the government also supports several such programs). Our work proves it is a mistake and that all support to livestock husbandry should be stopped as long as pastures outside forests are not established (which seem impossible because no land is available). Stall-feeding in particular should not be promoted as it makes husbandry profitable, whereas it is not profitable in its traditional form, meaning that traditional livestock husbandry should be (and is currently) naturally declining. Another strategic insight is that the focus should shift from compensations toward pastures. WCS is currently organizing a workshop on compensations and wants their implementation to be corrected to provide non-harmful incentive to farmers. We demonstrated compensations are in most cases not significantly harmful so resources should not be wasted on this minor²⁷ issue and should at the opposite tackle a major issue: forest pastures. Workshops could be organized to explain why they should be prohibited.

Finally, another strategic insight is that some drivers may have incentives too strong to be changed by new or corrected economic incentives alone (or that would be very costly) so the action of the State is necessary: to establish new regulations and to prohibit some activities. We were able to reveal this situation by calculating the opportunity costs of switching from the current activities to future *compatible* activities. A particular menace that need to be stopped by the State is the south-north railway project. We described how it represents a major threat that could destroy all hopes of restoration of tigers' previous range. strategic environmental actors may inspire themselves from the Hidrovia project (see Appendix B, I for a case study of advocacy against this project) where advocates of biodiversity proved the construction of dams to establish a navigable waterway would imply costs higher than benefits. To reach such results, they adopted a similar posture as ours and evaluated the value of economic activities themselves and not the value of biodiversity. Hopefully, the same can be proved for the railway: it may not bring benefits higher than costs.

²⁷ We need to qualify our statement: compensation can play a major role in places where tigers' attacks are extremely frequent. In these places, our calculations reveal that compensations allow the losses to transform into profit. In addition, compensations can play a psychological role that encourage farmers to stay in the business whereas they would have quitted it without them.

Chapter 3- The “economic assessment of biodiversity” approach

Our thesis is about reversing the burden of the proof in the struggle to protect biodiversity: instead of focusing in proving that biodiversity has a value in order to protect it, it may be better to show that adversaries of biodiversity's economic values is questionable. In this chapter, we study the expected gains from the economic assessments of biodiversity that have become so ubiquitous in the environmental economics literature. We have to stress that in this chapter we discuss economic assessment of biodiversity whereas in other parts of the thesis, we may be discussing economic assessment in general.

I. Assessing the value of ordinary or exceptional biodiversity ?

The report written by the French Centre d'Analyse Stratégique (Strategic Analysis Centre, CAS) for the French Prime Minister distinguished between two types of biodiversity (Chevassus-au-Louis et al. 2009):

- *exceptional* biodiversity which refers to entities (species, genes, habitats, landscapes) society identified as having an intrinsic value based mainly on non-economic values.
- *general* or *ordinary* biodiversity which does not have an intrinsic value but through its interaction and abundance contributes to ecosystem functioning and provide ecosystem services.

Chevassus-au-Louis et al. (2009) insist that this distinction is not only **biological** as it combines several criteria: **ecological**: rareness or key functional role if it is a species; **sociological**: "heritage" value; **economic**: importance of non-use values over use values; and sometimes **legal**: protected area or officially listed species.

In their methodology to assess the value of France's biodiversity, Chevassus-au-Louis et al. (2009) made the choice not to give an economic value to *exceptional biodiversity* (and to assess *ordinary biodiversity* only through the value of ecosystem services it provides). They did so because reference values for exceptional biodiversity are both:

- not credible in terms of reliability and accuracy of the valuations
- not appropriate in terms of insertion in a pluralistic debate mobilizing a lot of different values

We will come back on this second point in our **Chapter 4**. We share that analysis and believe *exceptional biodiversity*'s economic valuation is not that useful in the debate to protect it. We will however study what uses could in theory be and what real uses are in reality made of such a valuation. In Hunchun, both *exceptional* (the Amur Tiger) and *ordinary* (forest ecosystems) biodiversity can be found. When assessing the former, contingent valuation (CV) is one of the main available method and there was indeed a CV valuation of the willingness to pay for the protection of the tiger (Zhou et al. 2009). Assessing the latter is usually done in agreement with what Chevassus-au-Louis et al. (2009) recommend: it is the ecosystem services that ordinary biodiversity

provide that are evaluated and not biodiversity itself. Several such studies can be found in the Chinese literature (Wu et al. 2002; 王宗明 et al. 2004), even though they do not directly deal with Hunchun's forest.

But what values are we assessing exactly ? It is worth going back to basics and breaking down the values we can expect from the two types of biodiversity we just mentioned: the tigers and the forest ecosystems. We limit ourselves to the use and non-use values described in the TEEB (2010).

Table 16- Expected (theoretical) use and non-use values of the tigers (exceptional biodiversity) and forest ecosystems (ordinary biodiversity), adapted from TEEB (2010).

		Tigers <u>Exceptional biodiversity</u>	Forest ecosystems <u>Ordinary biodiversity</u>
Use value	Direct use value	Ecotourism; tiger friendly products; poaching; tiger-based Chinese medicines.	Provisioning services: timber, non timber forest products (NTFP, such as mushrooms)
	Indirect use value		Regulating services: water cycling; carbon storage.
	(Quasi) Option value		
Non-use value	Legacy / Existence / Altruism value	Existence of tigers in the wild: this is probably the highest value of tigers.	Cultural services: recreational activities; spiritual and aesthetic values.

All these values can be assessed and we will come back on the different uses in **this Chapter's III. Where does the value of biodiversity could and actually play in the logics of the drivers ?**. We will keep this distinction between the two types of biodiversity during the rest of our thesis.

II. What economic assessment of biodiversity can bring to conservation ?

Here we describe the expected type of uses of economic valuation of biodiversity. This applies to the situation in general and we first do not have a critical look on these supposed uses of valuation. We will then compare these expected uses with the observed uses in Hunchun in the **III**.

A. Ecosystem service valuation

In their review of the literature about the use of economic valuation of biodiversity, Laurans, Mermet, et al. (2011) specifically confronted the issue of the use of the economic assessments of the value of ecosystem services (which belongs to ordinary biodiversity; we come back on exceptional biodiversity on the section **B. Exceptional biodiversity valuation**) and what economists themselves have to say about them. They found three categories of use that we will briefly describe below.

1. Decisive assessment

The assessment is used *ex ante* by a decision-maker who faces different options and the assessment of biodiversity helps him to see the economic consequences on ecosystem services of each option. The assessment plays a key role in the decision, so **without it the decision would have been different**.

Three sub-categories can then be distinguished: **(1) assessment for arbitration** when it allows to add the value of ecosystem services to a costs-benefits analysis and let the decision-maker weight the different aspects and take a decision; **(2) participative assessment** when it does not bring a complete choice proposition but is instead the stake and the language of negotiation; **(3) assessment as an environment management criteria** which can show which management practices can maximise the ecosystem services provided to society.

2. Technical assessment

Sometimes decisions (to conduct a project, of a policy...) were already taken and the assessment is used *ex post* to adjust the economic tools that will implement them

Laurans, Mermet, et al. (2011) further detailed two sub-categories: **(1) assessment to determine the amount to be paid by agents liable for environmental damages** and **(2) environmental costing** which means either an assessment of external effects in order to internalize them or an assessment of the willingness to pay (or to receive), in both case the aim is to choose a price (of a product, of a PES, of a park's entry ticket...).

3. Informative assessment

If the assessment of the value of ecosystem services does not aim to change a specific decision before it is taken and if it does not fine tune an economic tool either, then it is probably made to inform the decision in general, in a more or less diffuse (not targeted) way.

Here again, we can find sub-categories: **(1) awareness-raising and advocacy** to take into account the environment into decision-making processes; **(2) justification** and support for one specific decision (that may have already been taken), but unlike in *decisive assessments*, here the assessment is not neutral, it instead tries to show that a specific decision is the right one to take, and **(3) assessment to create accountancy indicators** that take into account ecosystem services.

B. Exceptional biodiversity valuation

Assessing the value of exceptional biodiversity such as tigers usually involve contingent valuation (CV) methods (we can also cite choice modelling methods). Bonnieux & Rainelli (1999) described the use of CV in Europe regarding policies, regulations and projects. They distinguished three types of uses: **awareness, influence decisions and trade off alternatives**. The first two can be assimilated to the *informative assessment*'s “**awareness-raising**” and “**advocacy**” to take into account the environment that Laurans, Mermet, et al. (2011) described. Similarly, the last one is similar to the “**arbitrary assessment**” of the “*decisive assessment*” category.

Even though Bonnieux & Rainelli (1999) did not mention it, we can also think of possible *technical* use of CV of exceptional biodiversity such as choosing the price of an entry ticket to a park that hosts Amur Tigers by using the revealed (during the CV) willingness to pay of potential visitors. In the end, we can find the same theoretical uses of economic valuation for exceptional biodiversity and for ordinary biodiversity.

C. Underlying model of decisions

Economists believe evaluations of biodiversity can have the described effects (*decisive*, *technical* or *informative*, *supra*) because they assume **decision-makers seek to maximise economic efficiency** (Godard 1998) **and the social welfare**. By providing them with information about the environment, which can for instance help to evaluate the social marginal cost when the environment is degraded, evaluations can thus help them maximise these two aspects. Moreover, economists also implicitly assume there is one decision-maker (or one group of decision-makers) that is above everyone, above the fray and can take an informed decision.

Let's note that **in the SEMA approach**, the regulating actor does not play such a role: it can indeed take a decision but the decision is **based on the established balance of powers** between other agents. So the decision may induce a total lack of economic efficiency if that is what the dominant agents want.

Political sciences vision of decisions is different still: new policies are not based on an assessment of the problems in themselves but **in reaction to the consequences of previous policies** (Godard 1998). The economic efficiency criteria would only be an additional element of modern rhetoric deployed around public policies, it would have no *decisive* effect (*ibid.*).

III. Where does the value of biodiversity could and actually play in the logics of the drivers ?

After identifying the potential reasons to use economic valuation of ecosystem services, Laurans, Mermet, et al. (2011) conducted a comprehensive study of environmental economics papers. What they found is that the vast majority of environmental economists' articles deal with *informative* uses of evaluations. They do not study the use of valuations to change the decision (*decisive assessment*) or to adjust an economic tools that already exist somewhere in the world (*technical assessment*). Moreover, most of the time, articles only mention an informative use but do not study it in details. Is it the same with Hunchun actors ? Or can we see different uses of economic valuations ? We first detail the possible theoretical uses actor by actor then we describe which of these uses were observed in Hunchun during our field work. In the **Chapter 4**, we explore further hypothesis laid down by Laurans, Mermet, et al. (2011) to explain the use or non-use of economic valuation of ecosystem services (and we apply it more broadly to economic valuation of biodiversity).

We organised the potential and actual uses of the economic valuation of biodiversity in the table below. The usage categories are based on our description of the classification of Laurans, Mermet, et al. (2011) in the previous section. In Laurans et al.'s paper, *decisive assessments* were initially defined an arbitration regarding the use of public resources. But here we consider decisions taken after the main decision to protect biodiversity has been taken by the stakeholders and these subsequent decisions question whether to run or not programs that can possibly have a positive impact on biodiversity but for which we are not sure of the comparison of benefits and costs. These cases are blind spots of the article (*ibid.*) as they are not really arbitration about societal choices nor are they technical adjustment of the allocation of resources or tools. They arbitrate between launching or not a program that aims at protecting biodiversity, knowing that other can also be launched.

Table 17- Expected uses of economic valuation of biodiversity applied to Hunchun and its actors.

Report below the table for a description of each numbered item. The greyed cell corresponds to the economic valuations really used in Hunchun, others are - to our knowledge - not used.

	<u>Users</u>	Sector based agents	Environmental strategic agents		regulating actors ²⁸
			Environmental NGO (WCS, WWF, local Chinese NGO)	Environment-concerned scholars	Government
Types of advantages from assessment of the value of biodiversity	Decisive		(1) Feasibility and marketing study		(2) Arbitration
	Technical		(3) Budget allocation assessment		(4) Economic design of instruments
	Informative	(5) Risk economic assessment	(6) Advocacy	(7) Advocacy	(8) Economic information system and take advocacy into account

(1) is the only valuation of the value of biodiversity used to our knowledge. Actually it is not yet used but the Wildlife Conservation Society (WCS) plans to evaluate the market for ecotourism and tiger-friendly products, which would be a (partial) valuation of the value of tigers. Indeed, as we have detailed table 16 (*supra*), ecotourism and tiger-friendly labelled products correspond to direct use values of tigers. This evaluation would allow them to decide to put efforts or not in these two projects: if the value of tigers is sufficient (ie activities can be profitable) for such projects, then they will try, otherwise they will not.

(2) the government can use several economic tools that influences biodiversity. In Hunchun they are: compensation for wildlife-caused damage to crops, cattle or human life, subsidies to and taxes on agriculture, forestry and other sectors that affect biodiversity, PES for forest services. The anti-poaching laws are regulatory tools that also influence biodiversity (more precisely wildlife). Economic valuation of tiger provides information that could change the decisions for all the tools that affect its conservation. And for the PES, knowing the value of the services provided by the forests should help to take the decision to implement them or not. However, Landell-Mills & Porras (2002) reports that in the 72 cases of “*markets for forest biodiversity protection services in thirty three countries [reviewed]*”, none had a “*detailed and systematic cost-benefit analysis of the transactions they describe*”. Further, they explain that the environmental benefits of the PES reviewed are not monetised. To our knowledge, the decision to implement the current compensations of damages caused by all the protected animals (the animals causing damage are mainly wild goose, wild boars and tigers) was not supported by any valuation of the value of these

28 It could also be considered that environmental actors inside the government (eg the Ministry of the Environment) take decision to implement or adjust tools and projects by using economic valuation of biodiversity. They can also create information system or take advocacy into account and use evaluation as information. So we may not consider the government in this column but only environmental actors inside the government.

animals, not to mention the removal of taxes to agriculture and the implementation of subsidies that stimulates an agricultural sector detrimental to wildlife (including tigers) where no valuation was conducted either (to our knowledge). Economic valuation of biodiversity would have shown the value of tigers and if it had been linked to the impacts of agriculture on tigers (decrease of preys and habitats that reduce the carrying capacity of the available habitat for tigers), it would have opposed the removal of taxes and implementation of subsidies. It seems that the *decisive assessment* does not exist in Hunchun, which adds another stone to the idea that it is a chimera of economists (but further, more comprehensive and detailed studies of the processes that lead to these economic tools are still needed).

(3) WCS has several projects in China and has to allocate resources (money, staff) between them. In theory, it could use assessments of the value of the biodiversity it seeks to protect in each project to allocate resources the best way: more for the biodiversity of highest value and less for the biodiversity of least value. In practice, it is not (explicit anyway) economic valuation that prioritizes the projects (to our curious reader that would like to know what it is, we apologize: we only know what does not prioritize the projects but not what does, our resource did not allow us to answer that question).

(4) concerning the items in purple (concerning the assessment of **tiger's** value), it is very similar to (2) but here government could use the assessments to choose the level of taxation, of subsidy, the compensation payment and above all the amount of fines for illegal poaching. But that is not what is done at least for the only one we know: the compensation amount is equal to the market price for the animal killed, depending on its age, sex and breed. Availability of funds is also a key component and compensation amount may be lowered in the future as funds are always the same whereas compensation applications are increasing.

For PES, we are dealing with **forest** services valuation. China is home to the biggest PES scheme in the world: the Conversion of Cropland to Forest and Grassland Program (Grain for Green). This program is present in Hunchun too, though in a small scale. In the only example we have, 5000 RMB/year are paid for the conversion of 2.5 ha of crops to forest. That gives a value of 2000 RMB/ha and year or US\$ 333 per ha and year (with a rate of US\$ 1 = 6 RMB) that we can compare to the rough value of total forest ecoservices calculated by Costanza et al. (1997): US\$ 302 per ha and year, as this is a 1994 US\$, taking inflation into account will lead to a much higher value. So the payment is less than the value of the ecoservices and anyway, it is likely not to be based on any evaluation of this service. Regarding PES, we can cite another initiative where valuation of the value of tigers could play a role: the World Bank presented a new finance opportunity during a Global Tiger Initiative summit (Kieiss 2009): existing REDD+ scheme would be used and in addition to the original price of the carbon stored by forest, a supplement to the price would allow investors to buy “tiger REDD+” which come from forests that both store carbon and are tiger's habitat. To determine the increase in the price, the willingness to pay for tiger's protection of investors could be evaluated, it was however not mentioned in the World Bank document.

(5) If the law makes firms or individuals liable for the damage they cause to biodiversity (as it is the case in France for example: damage to biodiversity has to be prevented, if not possible then reduced and those that cannot be reduced must be compensated), or if it is likely to evolve and make them liable in the future, and further, if the extent of the liability is based on the ecosystem services destroyed, then firms should care about their valuation. This is however not the case in Hunchun. There is currently a train project shrouded in mystery (about its route, its planning...) that would go from Hunchun to the North. It is a government project but it is not promoted by the “regulatory actor” which has a neutral, judge role but instead by ministries in the government that indeed have a sector-based role (eg rail ministry). It would probably destroy a lot of forest area but

we never heard of an assessment of the value of ecosystem services destroyed. Sector-based actors (or ministries of the government that play a similar role) could also use valuation of biodiversity *a posteriori* to justify their projects, we did not hear of any example.

(6) To raise awareness, WCS could use (Zhou et al. 2009)'s contingent valuation of the WTP for the protection of the tiger to say that Harbin city's residents were willing to pay about 8 RMB/month for 20 years to protect the tiger which means a lot of money when aggregated. But WCS does not. Instead they organize a tiger festival with plush, tiger drawing contests for children, etc. The valuation could be used as a support for *naming and shaming*: point out and isolate people that exhibit behaviour damaging to tigers such as eating wild meat or poaching. Showing that the protection of tigers - and therefore tigers themselves - are important to social welfare (that is what the CV shows) demonstrates that behaviour that threaten tigers are socially damaging and viewed with disfavour by society as a whole. The RARE campaign lead by Lang Jianmin aimed at fostering pride of having tigers close their homes and unwilling to poach or eat wild meat (郎建民 2010). It however did not use any economics.

(7) Scholars can also use articles they publish or other published to **advocate** for the protection of tigers or forests (so it is an use of evaluations and not just a production). We did not find any example. If they work for the government, it falls in (2) or (4). Zhou et al. (2009)'s article only mentioned in one sentence that the CV could bring scientific support to management decisions about endangered species but it does not constitute advocacy.

(8) The government, in its *regulatory role*, can listen to advocacy by producers of economic valuation of biodiversity. It can also use/create new indicators to complement GDP and account for biodiversity capital. No indicator about biodiversity could be found on Hunchun's Government (2009)'s statistics.

For all the possible uses of valuation of biodiversity we tried to imagine, all but one were not actually used in Hunchun. And for the one which was, it was only at a project step: WCS plan to assess the market size for ecotourism and tiger-friendly products, which by the way is not the same as what environmental economists would do to assess the value of tigers. We have to qualify this remark: **the fact that we did not hear of all these uses do not mean they do not exist**. Our field work only lasted two month and a half and we had only a very superficial view of what the government and big firms were doing. But it is clear that for NGOs, the National Reserve and the compensation scheme, valuations of biodiversity were not used.

Why is that so ? This is the main topic of **Chapter 4** but we already mentioned some reasons at the beginning of this chapter: valuation for exceptional biodiversity are currently not reliable enough and they are not appropriate either on a pluralistic debate. When we discussed Zhou et al. (2009)'s article with WCS and with a local NGO protecting the tiger, they expressed doubt about its reliability. That may explain why the CV of the WTP to protect the tigers is not used. Ecosystem services valuation are more reliable and probably seem more robust to the general public. However, they may seem as inappropriate in some circumstances when other values are at stake.

IV. What values for tigers beyond the economic value ?

TEEB (2010) rightly notes: *“Protective legislation or voluntary agreements can be appropriate responses where biodiversity values are generally recognized and accepted. In such circumstances, monetary valuation of biodiversity and ecosystem services may be unnecessary, or even counterproductive if it is seen as contrary to cultural norms or fails to reflect a plurality of values.”*

Such biodiversity values exist in Hunchun: **(a)** as ethical views that we have an obligation to protect animals we put into jeopardy in the first place and **(b)** as religious beliefs that tigers are gods of the mountains (a ceremony to the tiger God was held in July in one village). However these two beliefs are not shared by everyone in Hunchun, far from that (the religious belief for instance is likely to be limited to some villages only). In addition to these beliefs, several campaigns from WCS, the Nature Reserve, the RARE campaign (who claims an awareness that snares can cause harm to Amur Tigers raised from 36.5% to 94% among farmers after the campaign 郎建民 2010) raised awareness about tigers and their conservation. Fascione et al. (2004) and Kruuk (2002), quoted in Broad & Damania (2009), also mention deep feelings associated with tigers, both **negative**: fear and defensiveness; and **positive**: aesthetic appreciation and cultural fascination. To repeat the words of TEEB, people in Hunchun area thus generally **recognize** and **accept** the tiger values. Valuation of biodiversity, if it is used to solve the issue we defined - the restoration of tigers population and habitat - may seem **inappropriate** by stakeholders, it may for instance be wrongly perceived as “putting a price tag on life of the tigers”.

Broad and Damania realized a more systematic list of the other values that can be associated to tigers: culture, ecology (tiger are at the top of the food-chain and their loss may have irreversible consequences for other species), ecosystems (tigers' habitats are diverse ecosystems that provide services to humans so conservation of tigers protect these ecosystems), biodiversity (same as with ecosystems but with biodiversity), indicator (the fate of tigers show what human society are more broadly doing about “sustaining environmental quality”). Interestingly, the authors did not list an **economic** value, even though tigers can bring money through ecotourism, tiger-friendly label or even trophy hunting if populations were more important. The description and mention of the **ecosystems** and **biodiversity** values is very telling: it shows that biodiversity and natural systems are not usually protected for themselves but need to be *free riders*, illegal passenger in another train that receives attention and protection, here the charismatic tigers.

Chapter 4- Hurdles to implement a conservation policy based on economic evaluation in Hunchun

We test two families of hypothesis formulated in “Why is actual use for decision-making the blind spot of ESV literature ? A review”, (Laurans, Rankovic, et al. 2011) to understand why economic assessment of environmental services values are in appearance not used, or at least not in a *decisive* way. Even though, we do not only consider economic assessment of environmental services, these hypothesis are still interesting for us. **One** is that **economic valuations need improvement**, and in their current state cannot be used, before they can be used, **the other** says that there is a **problem with the potential users** of the current assessments and the context must change for evaluation to be used. **We then explore new hypothesis that economic assessment may not be fit nor needed to influence the decision-making process.**

I. Economic evaluations need to be perfected

There were doubts about the contingent valuation of the value of the tigers (Zhou et al. 2009) when we presented it to different stakeholders: WCS and the local NGO protecting tigers (by the way they had never heard about it before even though their work is tiger conservation). They were worried about the quality of the valuation and this reflects possible methodology issues and flaws. Laurans, Mermet, et al. (2011) listed three potential such problems:

1. *inaccuracy*: results may not be **(1)** very reliable, **(2)** specific to their object or **(3)** able to describe it precisely.
2. *incompleteness*: valuation may miss economic aspects that are relevant for the decision-makers such as the distributional aspects (valuations usually focus on the creation of value for society but not on who gains and who loses). Laurans, Mermet, et al. (2011) actually named this aspect *inadequacy* and defined it more broadly: valuation would not capture all what is at stake for the decision. It would for instance miss non-economic values (such as human rights) that decision-makers take into account. However, we believe economic evaluations cannot be perfected to include these values and so it is not an improvement of economic evaluation that is necessary but additional tools; we develop this idea in our **III**. So we corrected the *inadequacy* and renamed it *incompleteness*.
3. **cost**: realizing an economic valuation would be too costly compared to what their use would justify or/and to the means of the stakeholders involved in the decision. This would be reinforced by the difficulty to transfer results obtained in one place to another because of the spatial scale (usually very local) and the specificity of the objects concerned by valuations.

In Hunchun's case, Zhou et al. (2009)'s contingent valuations' results may still be imprecise (though two different methods were used to check results in order that their relative weaknesses were compensated by the strengths of the other). However, the cost for the decision-makers is null as the study is already available. So is the problem *incompleteness* ? It may be the case as decision makers may want to know who will bear the costs of the protection of tigers (farmers ? taxpayers ?) and who will benefit from it (international community ?). Other economic valuations of biodiversity available for Hunchun context such as valuations of forest, grassland or all ecoservices of Jilin

province - or specific place in the province that are similar to Hunchun area - (Wu et al. 2002; 王宗明 et al. 2004; Bi-han & Ji-xun 2005) do not deal with the distributive issues and Zhou et al.'s valuation does not either. We were unfortunately not able to discuss with decision makers to ask them directly if this is what prevent them from using economic valuation of biodiversity.

We can note that economic assessment of the activities that threaten can suffer from the same weaknesses. In particular, if it focuses only on profits and costs as we did, it suffers from *incompleteness* as it does not catch **time** and **passion** (though we tried to incorporate this dimension with the **dashboard** and the **revenue formation** tools, see **Chap. 2, III. C. The typical household model**). In Hunchun's case, some villagers keep poaching because it does not need much time and they enjoy it as a leisure and a pastime. Similarly, some villagers do not start bee keeping even if it could earn money because they are not passionate about this activity.

II. The decision-making context is not favourable to the use of economic evaluations

A. Assumptions

Another sets of assumptions put forward by Laurans, Mermet, et al. (2011) and that can explain the lack of apparent use of economic valuations of ecosystem services (and that we extend to biodiversity in general) focus on the decision-making context. This context would not foster the use of such economic valuations because of:

1. **Insufficient economic education**: deciders would lack education in economics and would not be familiar enough with its language, axioms, logic and tools. They could also be nervous about using tools they do not fully master.
2. *Non conducive regulatory framework*: laws may not envisage and encourage the use of economic valuations of biodiversity and that would hinder their development. At the opposite and as in the USA, such economic valuations could be made mandatory by the law, which would create a “conductive regulatory framework”.
3. **Decision processes that need obscurity or ambiguity**: some decision-makers may prefer processes that do not shed light on distributive aspects or worse on deals that are not in the general interest. It would thus be a problem of politics and of the quality of democratic control institutions that would prevent a transparent debate and an outcome in the general interest.

So, to caricature, the solution would simply be to replace the current uneducated and corrupt decision-makers and legislators with technocrats qualified in economics who would pass laws forcing the State and firms to use economic valuations of biodiversity for every new law or project. Actually, economists indeed often complain about politics and politicians that according to those economists always ruin excellent economic ideas that would solve many problems if applied correctly (for instance the carbon tax in France).

The solution may not resemble such a caricature but anyway, according to this set of explanations, the issue would not be economic valuation of biodiversity cannot be *decisive* and change the decision by itself. Such an outcome (of a decision based only or essentially on economic valuation of biodiversity) should be possible if culture changed and more pressures were put to promote a better use of public money. We partly disagree with this and offer additional possible

explanations for the lack of use of economic valuation of biodiversity in our **III**.

Without developing it, we also offer another possible, context-based, explanation for the lack of uses of such economic valuations: **the insufficiency of advocacy from social scientists producing the evaluations**, both to explain the assessments and to argue how they can be useful for decision-makers (which also probably mean twisting these evaluations so that they better fit decision-makers' needs).

The existence of other (maybe more important) reasons do not mean the reasons given *supra* are not relevant. We show in the paragraphs below how examples from Hunchun fit well with these assumptions.

B. Test of these assumptions in Hunchun

1. Insufficient economic education assumption

People from WCS and local NGO indeed had no economic education. They are not public decision-makers but do take decisions of critical importance for the protection of tigers. And that lack of economic education indeed, according to my observations, seems to embarrass them in their use of economic tools, economic valuation of biodiversity included.

2. Non conducive regulatory framework assumption

Chinese law does not make economic valuation of damage caused to biodiversity or the environment mandatory to my knowledge. But if a construction project has a supposed negative impact on protected wildlife, an **environmental impact assessment** should be conducted (Seventh National People's Congress of the People's Republic of China 1988 Chap. II. art. 12), that does not assess the value of biodiversity though.

More broadly, in Hunchun **even if regulatory framework are somewhat favourable** to the environment, in their application, there is an **asymmetry in favour of the economy** against the environment: it is not surprising then that economic valuation of biodiversity are not used. For instance, human activities, and therefore pastures, are banned by the law inside the core zone of the Nature Reserve, which is favourable to tigers. But in practise, pastures are still tolerated by Hunchun's authorities on an historical and fairness argument: cattle husbandry was there before the implementation of the Nature Reserve so it would not be fair to in effect prohibit it by banning the use of pastures inside the core zone. How can you imagine an economic valuation of services provided by the forest could be used in this situation ? It would show the policy is critically detrimental to social welfare. This point actually goes in the same direction as the third hypothesis about murky political deals that need obscurity. Then, Chinese law (*op. cit.* Chap. II, art. 10) states that reserves should be created where wildlife under special State or local protection breed and live, which again is favourable to tigers. However, we note that in Hunchun, if the reserve was established there, it may be thanks to the border (we are only guessing here and we cannot submit any evidence though): the border belongs to a zone where activities are already very limited so creating a Nature Reserve there does not impede human activities much.

If it was needed, we give another example of economic interest preferred to environment ones : the construction of the railway from south to north (see **Chap. 2, IV. I. Road and railway building**). **(1)** the train will be built even though, if the law (Protection of Wildlife, *op. cit.*) was applied diligently, article 10 in Chapter II, that states environmental impact assessment have to be done may prevent the construction or at least could force it to adapt. However, there is only an

obligation to conduct such an assessment, not to take it into account, which means if there is no environmental actor ready to harass the proponent of the project, there will probably be no effect (Godard 1993). **(2)** The historic argument at play to allow pastures inside the core zone cannot work to plead the reserve was there before the train so the railway should not be built because it would go against the Reserve's aims for instance.

What we tried to show here is that even with conducive regulatory framework, uses of economic valuation of biodiversity would not be assured. Applications can differ from the original aims of regulatory frameworks and if nothing is done against the general asymmetry in favour of the economy against the environment, then conducive regulatory frameworks will be circumvented and made useless.

3. Decision processes that need obscurity or ambiguity assumption

This hypothesis is probably economists' favourite as it put the fault on politicians. It is a dangerous hypothesis as it can be used quite broadly to explain failure of economic valuations of biodiversity. The value of the tigers has been assessed but is not taken into account when a railway is constructed ? No need for further research: the explanation lies in hidden interests and murky negotiations. But beyond creating an easy scapegoat, this assumption may have some foundations.

Two key questions must be asked before we go further: **(1)** can this need for obscurity or ambiguity be changed ? If no, then economic valuation of biodiversity are useless because politics will always ignore them. **(2)** Is it detrimental to biodiversity ? And to social welfare ? If not, then it does not really constitute a problem. If politics needs a lack of transparency but in the end leads to solutions favourable to biodiversity, then we should not bother ourselves with economic valuations that bring an unnecessary transparency. **To the first question**, we answer both yes and no. Some kind of obscurity is necessary during negotiations: if all participants' interests were revealed prior to the negotiation, it would be very hard to reach an agreement. Imagine that you sell your house and that there is a lot of houses and buyers available so no one is worried not to reach an agreement the first time. Imagine you know the maximum price a buyer is willing to pay and he knows the minimum price you are willing to accept, now you will probably refuse to sell under his maximum price and he will refuse to buy above your minimum price. And it appear unmanageable and unimaginable to change the way politics operates in a short time period. Thus the “no” answer to the question: some decisions require obscurity. But at the same time, expectations can change and people may ask more transparency from public decisions and laws can be voted to limit obscurity about who profits from what. Thus the “yes” answer: in some circumstances and through cultural changes, more transparency may be brought to policy decisions. It is easier to answer **to the second question**: obscurity usually harms biodiversity and the social welfare, at least when special interests benefit from the lack of transparency at the expense of other interests (and the general public's interest).

In Hunchun, we can find examples of political agenda keeping some *incompatible* activities afloat. We defined *incompatible activities* in **Chap. 2** as activities that cannot be maintained if the *reference objective* of tiger's restoration is to be achieved. Some of these *incompatible activities* such as cattle husbandry benefit from support resulting from political motivations. Jilin is a 1st class meat producer and the government intends to further foster the meat sector.

"Jilin is a new center of animal husbandry and livestock production, the output value of which realized 39.9 billion RMB yuan in 2004, 42.42% of the total agricultural output value, and it has become the mainstay industry

of the rural economy. **Jilin Province ranks first in the quantity of meat per capita**, and fifth in the quantity of eggs per capita."

JILIN Provincial Communication Department n.d.

A plan has been designed at the national level to develop stall-feeding (Banshi's People Government 2011) and as we have shown, stall-feeding is also *incompatible*. So some activities are kept alive and even promoted whereas they are harmful to tigers and cannot be adapted to coexist with tigers. Such plans of course do not have interests in an economic valuation of biodiversity, especially if it showed the values of tigers (but would it really embarrass them ? Alone, such an evaluation does not show that such plans decrease social welfare).

Interestingly, economic valuation and not only economic valuation of biodiversity can be rejected altogether as it happened with WCS and a local NGO's artificial insemination program. Feeling the program may not be really profitable for farmers (because of implementation issues: the artificial insemination was likely to fail many times before succeeding in rendering the cow pregnant which means costs would be high), I suggested to assess the benefits farmers would gain from joining the program. The local NGO answered that it was not needed and that the most important was to prove to villagers environmental NGOs are willing to collaborate with them and improve their living conditions, not to ensure the program would run efficiently. But if villagers indeed lose money and the program does not work as planned, it may actually harm NGOs' credibility, so refusing evaluation may seem contradictory. This example clearly shows transparency is not looked for, at the opposite, it may be avoided.

III. A conceptual problem : economic valuation of biodiversity is not always fit nor needed

Even if perfected, economic valuation of biodiversity would still face hurdles. We cannot imagine to remove all the decision makers and replace them with economists who pass all sorts of laws promoting economic valuation and who take purely transparent decisions. **It would mean changing the whole society** because, in democracy at least, decision makers are chosen by the people, and it could also mean running into another type of problems and crisis because some ambiguity and obscurity is necessary for negotiations (otherwise no deal can be reached between two agents with different interests) and decisions. So instead of arguing that the decision context and attitudes must evolve, if we want to be able to use economic valuations of biodiversity and reach better situations in terms of social welfare, we should instead ask if economic valuation is really fit for the current decision-making structure ? And is it even needed ?

Even if it was perfected to take into account what it may not capture well today such as the distribution aspects and even if the context for its use improved with decision-makers understanding more economic concepts, new laws favourable to economic valuations and more transparent decisions, economic valuations of biodiversity may still not be used much. Sometimes situation indeed result from political choices that will not change when one learns the value of biodiversity for society (or even for himself). And this can happen because a myriad of values co-exist in our world, thus trade-offs between values are necessary . In addition, such valuations of biodiversity may not be really useful for decision-makers who cannot directly use them. Does this mean economic valuations of biodiversity are useless ? We discuss it at the end of this section.

A. Not fit: political choices that will not be changed by economic valuation

Knowing the value of tigers will not change the mind of people who do not want to coexist with them. Fascione et al., 2004 quoted in Broad & Damania (2009) thinks the fundamental question is: do we want to share our space with wild predators and tolerate co-existence ? Economic valuation may prove predators have a value for some people and so encourage stakeholders to share the burden of protection: those who benefit would pay and those who bear the costs would be helped. That is what compensation programs achieve: taxpayers or in some better cases environmental NGOs (who are the ones who want to protect wildlife) pay to compensate the loss of farmers caused by wildlife. But in a extensive studies of compensation schemes in the USA and of attitudes of people toward wildlife in link to these schemes, it has been shown that sharing the burden of protection may not solve the problem because we do not want to bear the burden in the first place:

“A second concern about predators that compensation programs could not address is the sentiment that residents simply do not want predators in the area.”

(Montag et al. 2003)

This is true for predators but is it true for biodiversity in general ? If we can find the same ingredients in other issues linked to biodiversity then the conclusions should be similar:

- economic activities' interests are opposed to environmental interests (eg pastures inside the forest are necessary for cattle husbandry but against tigers' interests) and the presence of biodiversity clearly goes against the logics of economic activities (eg pests in agriculture clearly contradicts the aim of maximising the yield of crops).
- historically the conquest on biodiversity has been seen as a sign of victory of civilisation against the wild world (as was the case for tigers, wolves but also as may be the case for wild forests)

When we distinguished exceptional and ordinary biodiversity (**Chap. 3, I. Assessing the value of ordinary or exceptional biodiversity ?**), we stressed **economic valuations of exceptional biodiversity may be especially unfit** because debates about this biodiversity are more driven by other values than economic than debates regarding ordinary biodiversity. We repeat this belief here: economic valuations are especially unfit for exceptional biodiversity and knowing its value in monetary terms may not trigger changes in the opinion people hold regarding this biodiversity, in particular for species considered harmful.

B. Not needed: economic valuation does not bring key elements to the decision

1. Decisions based on trade-offs between values

When we discussed the role of scientists regarding advocacy, we noted policy decisions are based on *trade-offs* between *values*. And **economic values** or **social welfare** as defined by economic theory is only one such value. As a consequence, an economic valuation of biodiversity that shows the possible consequences on social welfare of the deterioration or the improvement of an ecosystem will shed light only on one of many aspects taken into account for a decision. It does not mean it does not influence the decision but it may sometimes well be a drop of water into an

ocean, whereas sometimes the same kind of valuation may play a more significant role, depending on the particular circumstances and the associated *trade-offs* chosen.

But anyway, we do not need economic valuation of biodiversity to take it into account. Other values and methods are sufficient to decide to protect biodiversity. For instance, ethical views about the value of life, or the rights of indigenous people who are known to depend on biodiversity (but without the need to quantify this reliance) illustrate such values. And ecological studies of biodiversity to ascertain the conditions required for its protection coupled with studies showing how human activities impact these conditions allow to determine what actions need to be pursued, without the help of economics.

2. Economic valuation has little operational value

The typical examples of the use of economic valuation is a *decisive* one: a natural ecosystem provides a city with free and pure, drinkable water. The city has the choice between protecting this ecosystem or building a big water treatment plant to provide its citizen with water. The *economic value of the ecosystem* can be considered equal to the construction costs (and discounted operation costs) of the treatment plant. **In theory, if the costs of protection are inferior to the value of the ecosystem, the city should protect the ecosystem** and do not build the plant. In practise, to take the decisions, the city must arbitrate between values (for instance employment, as jobs would be created by the plant and other possible uses for the ecosystem's area) so valuation cannot be used alone. For *technical* uses, eg to choose a parameter of an economic tools, it appears that valuation of biodiversity is not of much use either. It is never used for payment for environmental services, as the value of ecosystem services is never calculated (Landell-Mills & Porras 2002). If you need to set up a compensation fund to compensate loss borne by farmers because of tigers, you do not assess the value of the tigers, you rather assess the value of their loss and compensate them accordingly.

Further, assessing the value of biodiversity does not tell us if economic or regulatory tools are necessary. Whereas we have shown assessing adversaries of biodiversity allows to calculate if they have negative, low or high opportunity costs and indicates what tools should *a priori* be implemented.

The stakeholders with whom we discussed in Hunchun did not reckon economic valuation of biodiversity had any operational value. We were far from discussing with all the stakeholders though and some may see things differently. For Li Zhixing, of a local NGO that protects tigers, the key to protect tigers is to build trust with villagers in order to develop good relationships with them and be able in the long term to influence their actions in a direction favourable to tigers. So he will for instance promote artificial insemination and the specialization of villagers (into only one activity that can be cattle husbandry or crops, etc.) even though this may be bad for tigers in the short term. He does not want to assess the effects on tigers, nor the effects on villagers' income, he just wants to carry programs that appear beneficial to villagers and that build trust with them. Lang Jianmin (we mentioned him in **Chap. 1, I. C. Case study area** as the head of the education and propaganda department of the Nature Reserve) pursues a change of mentality but he does not plan to reach such an aim through informative assessments of the value of tigers. Instead, he used moral and heritage values to persuade people that poaching and eating game meat is bad. For instance, his campaign's slogan was: *"Protection starts from our feet, home changes in our hands."* that emphasizes each person's actions influence its own home, its own heritage.

We can draw from Boltanski & Thévenot (1987)'s works cited in Godard (1990) on orders of justification. They covered all possible justifications people use in their discourse and introduced

the concept of *city* that people temporarily inhabits to justify themselves. A *city* possesses an ideal of *highness* and *trials* that one has to pass to reach the state of *highness* (ie to prove his value to others). One can use one *city* the morning to discuss with his family, then another *city* at noon when discussing with his colleagues and again another *city* when he negotiates with a car seller the evening. Economic valuations are part of the *merchant city*: the *city* where values are determined by buyers' willingness to pay and exchanges of rare goods happen in markets. In this *city*, something that cannot be exchanged has no value so economic valuations indeed have a major role as they give a value to something that had none. If everyone always used this *city* of justification, then economic valuations of biodiversity would always be *decisive*. But Li Zhixing and Lang Jianmin use the *domestic city*, which values family links, personal dependencies belonging to bodies, to lineages that go further than individuals. *Highness* is here defined by the relation to a memory and a transmission; heritage is a key notion. Li Zhixing and Lang Jianmin indeed justify their actions by the protection of relationships between close people (the villagers for the former) and the local heritage (“*home*” for the later). Boltanski & Thévenot explain that different cities cannot listen to each other, they can only reach unsatisfactory agreements such as compromises. Such an analysis partly explains why economic valuations alone can fail to reach their expected objectives: they belong to one city but agents can use other cities, making communication between the two very difficult or even impossible.

C. Economic valuations of biodiversity useless ?

To prove human activities have a negative impact on biodiversity, economic valuation are not necessary but **ecological** knowledge and the determination of the **chains of causality** are. To take into account biodiversity and decide to protect it, a **political** decision must be taken. Such a political decision is not taken based on only one value, such as the economic value. It is at the opposite based on a plurality of values. So economic valuation cannot alone be decisive.

As a resource for advocacy, the valuation of the adversaries of biodiversity should be more efficient because it shows where public policies can result in *perverse incentives* for drivers which should help to fight for the removal of such policies once the political decision and consensus to protect biodiversity is reached. Valuation of the adversaries also provides ammunitions to fight non profitable economic activities from a ground more tenable than valuations of biodiversity. The economic valuations of biodiversity are indeed still subject to controversies whereas accountancy is well-established and an analytical accountancy showing adversaries of biodiversity are not profitable should be harder to contest.

We believe economic valuations of biodiversity are not necessary in many cases. We maybe cannot manage what we cannot value but we do not need to value it in monetary terms. However, it does not mean they are useless. They still bring another value to the already present plurality of values and they may have an informative value toward the general public and decision-makers (that is problematic to quantify). As a final note about their use, we can only stress that if economic valuations of biodiversity want to be used, they need to solve problem of stakeholders and to integrate themselves with the essential features of the institutional context in place (Godard 2001). That surely means rethinking the valuations and first, before starting to conduct the evaluation of biodiversity, studying the institutional context and the stakeholders involved in decision-making to understand their needs and problems.

IV. Economic incentives and economic valuations

Economic valuation of biodiversity alone does not teach anything about economic incentives faced by the drivers that threaten it. In contrast, economic valuation of the adversaries of biodiversity reveal such incentives. It can thus be of great help to shed light on the effects of public policies and on conservation strategies. In addition, to reach the *reference objective* of the restoration of tigers' habitats and populations, it is not only necessary to create **new incentives** that effectively favour activities compatible with the objective (creating the Nature Reserve was *a priori* such an incentive but because the law is not strictly applied and human activities are still tolerated inside the Reserve, it does not produce the expected conservation effects), but also to remove **current perverse incentives** that have an adversarial impact on the tiger (eg subsidies to agriculture, compensations for wildlife-caused damage, free pastures in tigers' habitats).

"most international organisations call for the termination of harmful or 'perverse' subsidies (WTO 2000, OECD 2005, UNEP 2008, TEEB 2009)."

Fortuna et al. (2011)

The perverse incentives issue is thus well acknowledged but a work of identification and then of advocacy is still needed to get rid of these recognised scourges.

"According to OECD (2005), subsidies are often inefficient, expensive, socially inequitable and environmentally harmful, imposing a burden on government budgets and taxpayers, which are all strong arguments for reforming the existing subsidy policies"

Fortuna et al. (2011)

Economic valuations of the adversaries list all the incentives and can therefore allow to design effective incentives and understand why other failed and became perverse incentives.

We first give theoretical elements to judge economic incentives and then apply them to three examples from Hunchun that illustrate perverse and failed incentives.

A. Efficiency and relevance of economic incentives

Politically acceptable incentives are not always efficient. To really change drivers and entice people, an economic incentive must fulfil at least two conditions: **(1)** it must target the *relevant* driver, one that can induce reduction of activities in *incompatible* drivers, and further **(2)** it must give the correct incitations. We define an *efficient* incentive as one that gives correct incitations, ie incitations that have no additional harmful effects but at the opposite, trigger changes favourable to the *reference objective*. It should be noted that the correct incitations cannot be given to an irrelevant driver (eg if you want to restore tigers' population and habitats and that you target the candy sectors which is totally unrelated to tigers, then whatever you do, it cannot give correct incitations for the objective²⁹). So an incentive cannot be *efficient* if it is not affecting a *relevant* driver. In more details, here is how we judge of the relevance of the incentive:

- **target relevant drivers:** either the incentive directly targets an *incompatible* drivers or it targets a driver that can have significant influence on another *incompatible* driver.
- **do not target relevant drivers:** it targets a *compatible* or *synergistic* driver that is totally

²⁹ It should be qualified as we are in a general equilibrium economy and so what happens in one sector always have impacts in others. But for irrelevant drivers, the impacts are considered negligible most of the time.

unrelated to *incompatible* drivers and do not share any production input with them.

And, granted the relevance, here is how we judge of the efficiency of an incentive (it is initially designed to judge it *ex ante*, before its implementation):

- **efficient:** it brings the *reference objective* closer by removing or decreasing the intensity of an *incompatible* driver. To reach efficiency, several possibilities exist: **(a)** if an *incompatible* driver is directly targeted, the monetary transfer associated with the incentives is in absolute value higher than the *opportunity cost* to change from the current activity to a future *compatible* activity. So the economic unit (eg an household) is economically better off if it switches to the future activity. **(b)** If it does not target the incompatible driver directly, it needs to affect inputs used by the incompatible driver indirectly targeted and it has to consume them when they are needed by the incompatible driver, so that the incompatible driver cannot use them and the intensity of its activity is consequently reduced.
- **without effect:** relative to the *reference objective*, the incentive does not have any impact (but it may have other effects, on the household's living conditions for instance).
- **perverse:** it drives the *reference objective* away because it prompts households to start an *incompatible* activity or to increase the intensity of their current ones.

Close attention must be paid to these two problems of relevance and efficiency because as we will show, in reality, good ideas can affect irrelevant drivers, what we call *failed incentives*, or become *perverse incentives* that have a detrimental effect that further drives the *de facto* situation away from the *reference objective*. It should be the role of strategic environmental actors to advocate against such drifts and for incentives that **target relevant drivers** and are **efficient**, even though other forces often lead to such failed and perverse incentives.

An open question subsists: are economic tools more prone to implementation and politicking problems than regulatory tools (eg prohibition) ? Said differently: are failed incentives and perverse incentives more frequent when economic tools instead of regulatory tools are involved ?

B. Compensation and stall-feeding programs in Hunchun: perverse incentives

We already mentioned why compensation can be and in Hunchun is a perverse incentive in **Chap. 2, IV. C. 1. The additional issue of compensation**. Stall-feeding was also treated in **Chap. 2, IV. C. 2. a. Stall feeding**. Programs are seeking to promote it in Hunchun and their proponents are both the government and NGOs such as WCS. This is a great mistake since funding stall-feeding constitutes a perverse incentive. Here we deal with these issues using the fresh perspective we just pictured in the previous section.

Compensations in Hunchun concern all wildlife-caused losses to agriculture: both crops and livestock. In theory, losses are compensated at 100% of the market price of the goods lost and the only condition to get compensated (beside being the owner of the goods) is that the losses were indeed caused by wildlife. Bulte & Rondeau (2005) demonstrated why this acts as a subsidy to agriculture, increasing farmers' income and inciting them to farm more. In the case of livestock husbandry, it should mean more cattle raised and as a consequence, more cattle in the forests. As the increase in cattle husbandry activity is not matched by a decrease in other activities damaging to biodiversity (we explained in our thesis livestock husbandry is basically a secondary activity for which farmers never spend time if they must conduct other activities at the same time), the result is detrimental to biodiversity.

Compensation thus appears to be **relevant** as it focuses on an *incompatible driver* but it is a **perverse incentive**. Could it be made *efficient* by tweaking its rules or does the idea need to be relinquished altogether ? We could imagine forcing farmers to adopt preventive measures (such as guard dogs, fences, bringing back cattle at night, watching cattle during the day) in order to get compensations. But that may be very far from the economic optimum as costs may be very high for very low benefits, especially for farmers whose herds very rarely get attacked by tigers. In addition, it would still constitute some kind of subsidy to agriculture and encourage villagers to start or intensify the activity. **We believe compensation should at least be replaced by insurance and ideally by a tax or a quota that would send a more efficient incentive to farmers** (regarding the *reference objective*).

C. Bee keeping in Hunchun: a failed incentive

An example of an good idea that has been transformed to accommodate private interests and has ended up being a failed incentive is bee keeping. WCS's initial idea was promising: to implement economic incentives to change behaviours. But WCS failed to identify the *relevant* targets (free pastures in the forests, fines and frequency of control against poaching). WCS agreed to finance the purchase of honey boxes in contracts with villagers; it may have believed that even though the promotion of bee keeping did not constitute a *relevant* incentive, it could contribute to the preservation of tigers if the contract asked the villagers to conduct conservation-friendly practice (see paragraph). Villagers thus can practise bee keeping with almost non-existent costs and can increase their income. But as bee keeping does not require much inputs and anyway no input needed by other activities, it is not a *relevant* target because it cannot influence significantly an *incompatible* driver. In particular, bee keeping does not require time when time is needed by other incompatible activities: cattle husbandry already does not need much time so bee keeping does not influence it and villagers poach during winter when bee keeping does not require any attention.

Bee keeping is thus **not a *relevant* target driver** and incentives that target it **cannot be *efficient***.

However, in the contracts with WCS, villagers agreed to participate in winter anti-snare patrols and to inform WCS if they notice any clue of wildlife activity (especially tigers activity). Patrols are not extremely efficient regarding the number of snares they remove and we can consider such an agreement does not directly contribute to reaching the *reference objective*. It nevertheless indirectly does because it raises awareness about wildlife and increase social pressure against poaching. But it would be more cost-efficient to sign such a contract associated to an *efficient* incentive.

Conclusion

“**Adversaries of biodiversity**”: these words may seem too harsh and dogmatic, they may scare protectors of biodiversity who do not want to be seen as environment fanatics but instead want to build relationships with all the stakeholders and cooperate to solve environmental issues. We have shown that the concept is valuable to solve environmental issues though. For us, cooperation is only one aspect of environmental issue solving, the other being a “**fight**” - again a word too harsh it seems -, a struggle between competing interests. We recognize these words of adversaries and fight should not be used because they indeed are too harsh and can alienate potential allies of the protector of biodiversity. The threats on biodiversity caused by economic activities are usually undesired side effects, so these activities are not voluntarily adversaries of biodiversity, but they may know their impacts and still refuse to change their behaviour, considering other values prime on biodiversity. The actions, decisions and negotiations required to protect biodiversity may not involve physical fights but interests are very often opposed between different groups of people and stakeholders will have to act strategically, face pressures and resistance (that can actually sometime be quite violent) from opposed interests. As a consequence, these two ideas should be kept in mind even though they are too extreme and controversial to be directly used and mentioned.

Our main results concern **(1)** livestock husbandry, **(2)** the use of economic valuations of biodiversity and **(3)** strategic insights for conservation.

First, we listed all the economic incentives faced by livestock husbandry which allowed us to carry out the analytical accountancy of this driver. In appearance, when we take into account only the monetary transfers that really affect the bank account of villagers, the **apparent profit** is positive: the only cost is a very cheap transformation cost of farmers' own production. But the **real profit** of the activity needs to take into account the opportunity cost of these feeds given to cattle and not sold on the market: this opportunity cost tips the profit into loss. Compensations do not bring back the profit into positive and its effect is, in average, very low so even though it is a *perverse incentive*, it does not represent a major source of concern (except for areas with attack rates 25 times higher than the average, for which compensation bring back the real profit into positive and can thus constitute a major incentive to pursue cattle husbandry but such places should be very limited in area and number). However, we identified **a critical *perverse incentive*: free common or State pastures located inside forests**. In most places, during seven month and a half, cattle graze inside these forests which provide them with free feed. Without these pastures, this activity would really lose a lot of money and would probably be not pursued at all. But more importantly, without these pastures inside the forests, cattle husbandry would become *compatible* with the *reference objective* (it means that even if a small fraction of farmers keeps raising cattle and the total number of heads remains stable or even increase but they do so outside pasture forests, it would not be harmful for tigers). Indeed, the incompatibility of the cattle husbandry activity stems from the diffuse competition between cattle and ungulates (preys of tigers) inside the forest. Our results are based on some key assumptions that greatly influence the results: the main one corresponds to the proportion of natural loss. We considered a 13% of heads loss every year which is based on the average loss (including loss to tigers) reported by farmers during WCS Summer 2011 survey. The sampling counted more than 100 households and we believe it was representative. However, we showed (with what we called the *basic assumptions*) that a low rate of loss implies the real profit becomes **positive**. But it does not alter the results about compensations or free pastures: these pastures still shrink the profit and transform it into a loss.

Second, we extended the results and hypothesis of Laurans, Mermet, et al. (2011)'s article about

the use of economic valuations of ecosystem services: their categories of evaluation's uses can be extended to the valuation of biodiversity in general. We then imagined possible *decisive*, *technical* and *informative* uses for Hunchun's situation and looked for evidence of such uses. This research is not exhaustive and thus should be taken with a pinch of salt but we found only one use of evaluation of the value of biodiversity: an evaluation of the market for ecotourism and tiger friendly labels. This evaluation has not even been realized yet, WCS only plans to realize it. A more exhaustive research needs to be conducted, especially with government officials (which we were usually not able to interview), but we believe it is likely that economic valuations of biodiversity (of the tigers and of ecoservices such as forests' services) have not been used. Our approach is innovative: **it starts from expected uses and then compare them with the reality to reveal what are the actual uses.**

Third, we provide strategic insights that would not have been reached without following an approach similar to ours: we first identified *incompatible* activities and then determined their *opportunity costs* to switch to future *compatible* activities. Our methodical approach reveals that behind a stall-feeding activity that intuitively seems favourable to conservation (it should decrease the number of cattle in the forest), the first year of all heads of cattle and the majority of the life of cows must take place in the forest. As the most harmful factor for ungulates is human disturbance in the forest and not cattle presence, stall-feeding is actually incompatible with the *reference objective*. As a consequence, a good strategy would stop promoting stall-feeding (WCS and the government currently do promote it) and would stop all supports to cattle husbandry altogether to focus instead on limiting or even prohibiting pastures inside the forest (especially inside the Nature Reserve where it should already be the case).

In the introduction, we detailed three main research questions. What can we answers to them now ?

What are the characteristics of the *adversaries of biodiversity*, ie the activity sectors that threaten biodiversity ? What are the different kinds of incentives that drive them to threaten biodiversity ?

We offered a typology to characterize the activity sectors that threaten biodiversity: they can be *incompatible*, *compatible* or *synergistic*, then have *low*, *high* or *negative opportunity costs*, we can also characterize them through their costs and profits. We then built on this typology to determine whether direct advocacy based on economic arguments can be tried or not, and which kind of tools (information, technical support, economic or regulatory tools) are *a priori* sufficient to tackle *incompatible* drivers. Actually, information is likely to never be enough because if non profitable drivers are still present, it surely means some other reasons (for instance politics or a private interest that benefits from their activity even though it loses money) keep them alive and people who benefits from them will resist change. Economic incentives that drive sectors to threaten biodiversity (prices, taxes, monetary support measures from the government, costs...) must all be listed and the analyst can draw a **dashboard** of incentives, that also needs to be completed with cultural and social incentives, available assets and environment conditions. Such a dashboard allows to organize and displays available information. Incentives that encourage more social damage than would occur without them can be defined as *perverse incentives* and our methodology allows to identify them (we identified for instance the free forest pastures).

We question the use of economic valuations of biodiversity. Are they not decisively used because of problems linked to the quality of the evaluation itself and so its perfection would be needed ? Or is it because decision-makers and decision-making context is not favourable to the use of economic evaluation of biodiversity ? So may it

be a problem of divergent, **conflictual interests** instead of a **cooperation** problem ? It may also be that economic values are not alone in town and thus decisions are influenced by other values, making economic valuation not as useful as expected.

We were able to find examples to illustrate all the mentioned reasons. This demonstrates that economic valuations of biodiversity are not used decisively **for a set of reasons**, among which the need for an improvement of the valuation and an unfavourable context that if changed would promote the use of such valuations. We mentioned how choices about biodiversity are also political choices (in the sense of choices made by individuals about how they aspire to live) that will not be changed by a demonstration of the value of biodiversity for society provided by economic valuation. And finally, we argued economic valuations of biodiversity illustrate the value of biodiversity but this value is only one among many and decisions are based on trade-offs between values which means economic valuation of biodiversity alone cannot be decisive. One could argue that then it is not an intrinsic problem of economic valuation and that it only needs to be perfected to include these other values. However these other values are out of the scope of economic valuation. **What could be perfected are the elements provided to decision makers**: economic valuation of biodiversity should only be one part of them and it should be accompanied by ethical elements, social impact assessments, ecological assessments of the minimum conditions required for ecosystems and species and causality links between human actions and damage to the environment. In the end, we also pleaded economic valuation of biodiversity had sometimes little operational value: it does not provide additional elements to determine which drivers need to be targeted by conservation policy and it does not explain how to design and implement these policies.

Is it possible to change the economic incentives faced by *adversaries of biodiversity* to implement effective conservation policies ? How to change the right economic incentives ? What happens if the concept is good but the implementation bad ? Is it possible that some drivers which threaten biodiversity are sometimes too well established and hard to change through economic incentives alone ? Can other tools such as regulation and information help ?

To answer this final research question, we dealt theoretically with the use of economic tools to change the drivers: the *opportunity costs* to switch to a future *compatible* activities give indications about the feasibility of economic incentives. Then we defined criteria to judge if incentives are *relevant* and *effective*. We argue that it may cost too much money to implement conservation policies with only economic incentives when *opportunity costs* are high (regulatory incentives will be necessary). And when it is possible to use economic incentives, to change the right ones, it is necessary to target directly or indirectly *incompatible* drivers and to ensure not only that the new incentive affect inputs used by this target but also that it does so when these inputs are needed by the target. Otherwise, the incentive will be inefficient (such as bee keeping in Hunchun), or worse, if badly implemented, it will become a *perverse incentive*. That happens when either the wrong driver has been targeted and as a consequence an *incompatible* driver is encouraged as if it was *compatible* (as with stall-feeding in Hunchun), or when the incentive does not seek to address input uses by the driver and its impact on biodiversity (such as with compensations in Hunchun). In conclusion about economic incentives and conservation policies: (1) *incompatible* drivers must be targeted directly or indirectly (through other drivers that share the same input at the same time); (2) the opportunity cost must be calculated to verify the driver can be influenced by economic incentives; (3) existing incentives and characteristics of the drivers must be determined (that is where the economic valuation of the adversaries of biodiversity is used) so as to check the new incentive will indeed affect the right inputs (eg analysing husbandry reveal that inciting households to spend time in summer will be irrelevant because time is not an input required for this activity in

summer); and (4) in the end, after implementation, the driver must be monitored in order to adapt incentives if they appear to be failing or presenting harmful effects.

Before ending our journey, it is necessary to light the way that lies ahead: our study focused on the definition of *the environmental problem* as an entry point into *the collective action problem* and its description of the interests of the different agents but we did not study the *decision processes*. Paying attention to these decision processes, their rules and their results will probably help to refine the advocacy tools we offered in this thesis. By focusing on decisions and their protagonists, researchers will also probably more easily find if and how decision-makers might use economic valuations of biodiversity. Similarly, we were not able to pay special attention to sectors and the links between agents of the same sectors. Studying sectors is necessary to improve our advocacy tools. We believe the tracks we have established to analyse the activity sectors that threaten biodiversity through their economic valuation should be tested and extended in a case study of the use of such an evaluation, for instance NGOs could conduct such an advocacy and researchers would both help and study them. In the end, replications of our method regarding the use of economic valuations of biodiversity (imagining possible uses and comparing them to actual uses) could help to determine the current uses of valuations of biodiversity.

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Appendix A. Income sources

name	externality	percentage	money_value	source_name
Costs for crop production (seeds, fertilizers..)	FALSE	-23,4	-13858	Hunchun market ³⁰
Sell crop	FALSE	51,4	30487	Own assets
Compensation for crop loss	FALSE	0,8	484	Hunchun government ³¹
Crop loss to wild animals	TRUE	-2,7	-1626	Wild animals ³²
Crop subsidy	FALSE	7	4157	State government
Average compensation	FALSE	0,4	247	Hunchun ³³ government
Sell honey	FALSE	21,6	12788	Natural asset outside forest
Free forest pastures	TRUE	28,3	16765	Forest
Average cattle loss compensation	FALSE	0,1	63	Hunchun government ³⁴
Apparent cattle	FALSE	-0,5	-268	Hunchun market

30 Could have been affected to “Own assets” instead.

31 Calculated from compensation's data for Chunhua in 2010. There is a discrepancy between the amount compensated and the market price and therefore the loss is superior to the compensation.

32 Calculated not from direct data on the average loss but from compensation's data for Chunhua in 2010. It may therefore be an underestimation (because some people may not report loss for compensation).

33 We consider the typical household owns 3.46 ha of crops. We obtain this subsidy amount by multiplying it by the compensation per hectare from our micro economic data.

34 We consider the typical household owns 8 heads of cattle. That is the average compensation for 8 heads.

husbandry costs				
Average cattle loss to wild animals	TRUE	-0,1	-63	Wild animals
Opportunity cost of soya and corn fed to cattle	FALSE	-8,4	-4950	Own assets
Sell cattle	FALSE	6,2	3673	Own assets
Other natural cattle loss	TRUE	-1,6	-977	Own assets
Sell NTFP Spring	FALSE	2,8	1635	Forest
Sell NTFP Autumn	FALSE	2,8	1635	Forest
Average wage for work outside	FALSE	6,9	4088	Employer

Appendix B. Other case studies from literature

I. Hidrovia

A. Situation

Hidrovia is a 3400km north-south waterway project that would link Bolivia, Brazil, Paraguay, Uruguay, Argentina and the Atlantic Ocean (Gottgens et al. 2001). It would go from Caceres in Brazil to Nueva Palmira in Uruguay. This waterway would ensure year-round navigation, bring economic benefits to the 5 countries and promote regional integration through the Mercosur. Actually, the river is already navigable but the project would straighten and enlarge it so that large barges would be able to navigate it throughout the year.

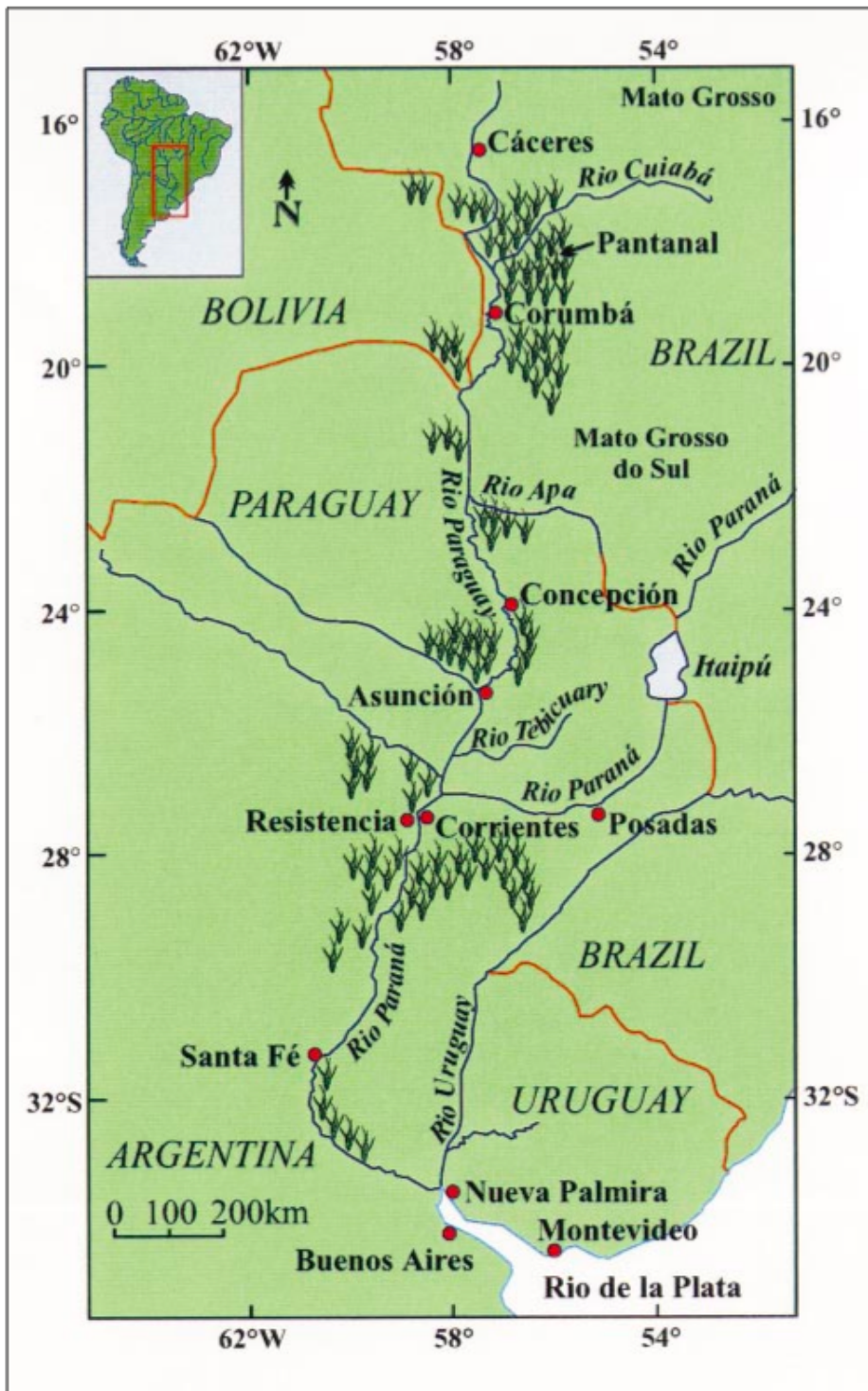


Figure 1. The Paraguay-Paraná Basin is in the heart of South America. It is roughly 10 times the size of the Florida Everglades.

Figure 14- Hidrovia's situational map (source: Gottgens et al. 2001)

The Pantanal forms the world largest wetland (Gottgens et al. 2001) and it would be affected by

the Hidrovia project. It was designed a National Heritage site in the Brazilian Constitution and includes 2 national protected areas.

B. History

We offer below a quick time line of the Hidrovia project:

- **a hundred years ago**, politicians already dreamt about a channelised waterway into the heart of South America
- **in the late 1980s**, the La Plata Basin countries (Argentina, Bolivia, Brazil, Paraguay, and Uruguay) agreed to initiate the Hidrovia project.
- **September 1989**: Creation of the Intergovernmental Committee for Hidrovia (CIH). The project would be funded by the Inter-America Development Bank.
- **1992 (or 1990 ?)**: economic feasibility study by a Brazilian firm, Internave
- **1995**: the economic feasibility study is contested and it is affirmed that environmental costs must be considered. By including these costs (such as additional dredging because of greater erosion), the project would not be profitable (Bucher & Huszar 1995).
- **1995 - 1997**: a new environmental impact assessment is conducted for the CIH by international consortia of consultants. It concludes that Hidrovia would benefit the region with minor environmental impacts
- **1997**: a panel of experts convened by two NGOs concludes that the engineering studies were incomplete, did not address the long-term implications of water-level changes on the floodplain and that a thorough environmental assessment was still lacking (Gottgens et al. 2001)
- **1998**: Brazil abandon plans for constructed activities along its part of the waterway, the federal government stops studies and engineering works. But other countries (and some initiatives in Brazil also) keep dredging and straightening the river. These combined small alternatives may result in a worse outcome than a more holistic approach ("*tyranny of small decisions*"). (Gottgens et al. 2001)
- **2001**: the project is still on hold (Gottgens et al. 2001)
- **2010**: the project comes back at a meeting of the Brazilian Ministry of Transport ? (<http://www.riosvivos.org.br/Noticia/HIDROVIA+PARANA+PARAGUAI/16896>)

C. Advocacy

Bucher & Huszar (1995) are clearly advocating against the Hidrovia project. To convince the reader, they use a **Benefit-Cost analysis** and starts from the Internave's 1992 report.

1. they demonstrate the report was full of miscalculations and the internal rate of return was therefore overvalued
2. Internave (1992) had only taken into account the costs of construction, maintenance and equipment and the benefits resulting from savings in transportation costs, but Bucher & Huszar (1995) argues that the environmental costs (here costs that would really have to be borne by Hidrovia such as additional dredging and not environmental losses converted into an economic value such as a loss of biodiversity) must also be taken into account. They calculate the sensibility of the rate of return to the increase in the costs and find that if environmental costs increase by 20%, that is \$40 million, the projects internal rate of return

would be less than 12%, the threshold for a project to be considered as profitable by the Inter-America Bank of Development

3. through a “back of the envelope” calculation and the use of references, they find that additional dredging linked to increased erosion would cost about \$39,6 millions. So even without taking into account loss to fisheries and tourism, the environmental cost would make the project non-feasible.

Bucher & Huszar (1995) were probably instrumental in the realization by the Inter-America Bank of Development and the UNDP that the Internave’s feasibility study was seriously flawed and their decision to conduct a new study in 1995. **Their approach can be summed up as: (1) point out the mistakes of your adversary, (2) discuss the hypothesis, (3) bring new data in your favour. They do not leave the Cost-Benefit analysis’s conceptual framework.**

Gottgens et al. (2001) use several types of argument to advocate against Hidrovia:

- scientific evidence that shows the hydrological situation will worsen.
- empirical evidence that the situation has worsened because of man’s work on the river: 1998’s flood in Argentina.
- challenge of the hypothesis in the economic assessment: overestimations of the benefits and underestimation of the costs. Though references are made to other articles with more detailed criticism of the hypothesis, this challenge is not supported by figures in Gottgens et al.’s article. The authors also point out the feasibility study conducted failed to consider alternative solutions such as rail roads, existing waterways... Furthermore, the waterway is already navigable half the year and during the main harvest months. So Hidrovia is not necessary.
- impacts on indigenous people have to be taken into account.
- experiences of other huge waterway projects (eg Everglades - Kissimee River complex in Florida; Missouri - Mississippi River system) warn that huge negative long term externalities exist. It shows the pitfalls of altering the hydrology of the Pantanal.

A point is also made that economic activities around the waterway can use other ways to transport their goods and that it may not be that easy for them to switch all their transports to the Hidrovia waterway if it is built (as is assumed in the Internave 1992’s study) because they may have bought capital such as trucks and shipping terminals, they may have contracts or personal relations with people working in other mean of transportation, etc. (Bucher & Huszar 1995; Gottgens et al. 2001; de Resende & Tognetti 2002). But there is no figure.

So here again, we find an *adversary of biodiversity* that is *incompatible* (relative to a reference of the preservation of the Pantanal ecosystems) and appears to constitute a *market anomaly*. Economic valuation of biodiversity was not employed but economic valuation of the adversary itself was; and it was been called into play as an advocacy tool (that may have been instrumental to encourage further study and slow down the project, even though evidence of its precise role are lacking).

II. Elwha

A. Situation

The Elwha dam was located in north west Washington, USA (see map below), 4.8 miles from the mouth of the river. No accommodation was made for the salmons that previously lived there and thus the dam completion meant the loss of about 105km of high quality salmons (Gowan et al. 2006).



Figure 15- Elwha situational map (source: Warrick 2005)

In the mid 1980s, the relicensing process for the dam began. The Federal Energy Regulatory Commission (FERC) has extended powers to relicense dam operators. The Federal Power Act instructs FERC to strike a balance between hydropower development, navigation, recreation, fishery resources, and other competing uses. FERC's authority is not absolute though and Federal

agencies have a say. *“Other organizations, such as environmental and local interest groups, can request formal recognition to comment and participate in the process as an intervener but have little authority to influence a licensing proceeding beyond the power of persuasion.”* (Gowan et al. 2006).

In the case of the Elwha dam, it quickly appeared that to restore the river to its full biological potential, the only solution was the dam removal (see **B. History** below). A balance between “hydro power development” and “fishery resources” had to be struck. The different main interest groups were:

- **the FERC** who had to take the decision about the conditions of the dam relicensing (removal, retention with adaptation measures ?)
- **James Water** who owns and runs the dam during the relicensing process and wanted of course to continue using the dam as before
- **several federal resource agencies** (Fish and Wildlife Service (FWS), National Marine Fisheries Service (NMFS), National Park Service (NPS), and the Washington Department of Natural Resources (WDNR)) whose members in the end wanted ecosystem restoration and dam removal
- **the Elwha Klallam Tribe** who also wanted restoration of the previous state of the river

B. History

Simplified from Gowan et al. (2006):

- **1913**: completion of Elwha dam with no fish passage measure.
- **1926**: completion of a second dam 14km upstream of Elwha dam: Glines dam with no fish passage measure either.
- **1938**: Congress established Olympic National Park (ONP) on lands surrounding the Glines project.
- **through the 1970s and the 1980s**, a private firm called James River owns and runs the 2 dams and employs them to generate electricity for its paper and pulp mills.
- **mid 1980s**: the process of relicensing begin
- **the transformation of the debate: 1985-1988**:
 - when the process of relicensing begin, it is inconceivable to remove the dam
 - production of a report evaluating different alternatives to pass fish around the dams: it reckons that prospects for restoration are dim.
 - federal agencies seem ready to accept modest fish passage alternative and drop the full restoration of the ecosystem.
 - **January 1986**: in its motion of intervention in the relicensing process, the Elwha Tribe asked for the dam removal. They considered the Elwha river to be part of their cultural heritage and the dam construction a profound injustice, moreover they believed the dam removal would allow the full restoration of the salmon population. They do not have recourse to any technical analysis (none has been conducted).
 - **May 1986**: a coalition of environmental groups fills for the intervener status in the relicensing process and also advocates for the dam removal.
 - **December 1986**: the Washington Department of Game, Elwha Tribe, Point-No-Point

Treaty Council (a regional council of native American tribe), Department of the Interior, and National Marine Fisheries Service form a group called Joint Fisheries and Wildlife Agencies (JFWA) to coordinate their actions. They petition FERC to order several analysis and a minor component of the overall request is the removal of the dam (they do not really believe it to be possible).

- **May 1987:** FERC requests James River to conduct the analysis requested but do not mention the dam removal.
- **May 1988:** James River publishes the results of a cost analysis of the fish passage construction costs and the associated power forgone and of the modelling of the return of the salmons. The model shows that even with fish passages, restoration would fail for all but one specie of salmon.
- JFWA biologists evaluate the biological potential of the pristine river habitat and show that if perfect conditions were met (among them, no dam), the river could host a wide variety and a huge number of fish.
- **August 1988:** JFWA informs that it wants “*restoration of the ecosystem or full recompense for losses*” and that dam removal must be considered. That is a change from the agencies 1985’s position.
- **Escalating conflict, entrenchment, and resolution: 1988–1992**
 - **December 1988:** James River tries to demonstrate that fish passages can actually obtain some satisfying ecological results. It also commissions a dam removal study. This study argues that severe impacts would occur for 20 years because of unmanaged release of sediments.
 - the Elwha Tribe funds another study that argues that impacts from the sediments can actually be minimized.
 - a prospect document sums up the differences in biological prospects for the fish species between the 2 options of dam removal and retention. This summary helps participants to observe clearly the trade-offs.
 - **August 1989:** FERC reverses its May 1987 decision and orders James River to produce analyses of dam removal plans. An Environmental Impact Assessment is also launched.
 - **December 1989:** James River releases the analyses that list the costs and consequences of two dam removal options.
 - From this point, both sides (James River and JFWA) know what the other wants and do not want. They try to develop arguments to convince FERC and also prepare themselves for the eventuality that they need to go to courts. They use hydrologic models, biologic models and cost analysis of the different alternatives (options for dam removal, options of fish passages...).
 - **1992:** by this time, a court challenge seems inevitable, regardless of FERC’s final decision. But Congress intervenes and calls for full restoration of the Elwha River ecosystem and the native anadromous fisheries which means unambiguously dam removal. Congress removes the liability of removal from James River: the dam will be nationalised, moreover, replacement power is guaranteed from another source.
 - 3 studies are conducted:
 - one goes further about the technical details on how to remove the dam

- another confirms that dam removal meets the restoration target better than dam retention + fish passages. **For the first time, a monetization of the benefits of the dam removal is conducted and it concerns the direct benefits of increased recreational and commercial fishing.** A contingent valuation study is also conducted about the citizen's willingness to pay at a local, state and national level for the removal of the 2 dams and return of the Elwha river to its natural condition.
- the last one identifies the preferred dam removal option.
- **2001:** Congress eventually unblocks funding to buy the dams
- **2006:** the dams are still in place and have still to be removed even though the decision has not been reversed.

C. Advocacy

The groups that advocated for the removal of the Elwha dam were doing so on an ethical basis. On the first stage of discovery (see **B. History** above), they were not yet grasping what represented for them the value of the fully restored, dam-free, ecosystem. Gowan et al. (2006) suggests that a contingent valuation would have proved inefficient at this time.

Later, on the conflict stage, the different actors advocated in favour of the dam removal or retention by using biological models to determine the feasibility of the restoration success, hydrological models to predict the impacts of the removal of the dam and economics were used only to calculate the costs of the different options.

That is only after the US Congress decided that full restoration had to be achieved (that is, implicitly that the dam had to be removed) that the proponents of the dam removal decided to monetize the benefits of the ecosystem restoration. They first assessed the direct benefits of greater commercial and recreational fishing activities. These readily monetized benefits were lower than the costs of the restoration. Another assessment through a contingent valuation to “*estimate citizen's willingness to pay at the local, state, and national levels to remove the two dams and return the Elwha River to its natural condition and restore wild salmon runs through dam removal*” (Gowan et al. 2006, p.518). Gowan et al. reckon that this latest contingent valuation was not necessary to keep the support of Congress for the removal of the dam, nor was it instrumental to get the funding necessary to really remove it. Indeed, in 2006, 5 years after the Congress's decision, the dam was still unremoved and the funds still needed.

Economic valuation is useless because during the negotiations for the relicensing of dams, “*participants are willing and able to weigh ecosystem services against market outcomes (for example) in a mutually satisfactory way without the aid of ecosystem valuation*” (Gowan et al. 2006, p.521). Gowan et al. advices to ecological economists to pay attention to “*other analytical contributions beyond monetization studies that might be more influential in ensuring that appropriate weight be given to ecosystem services*” (*ibid.* p.521). These analytical contributions would be more familiar to the participants and in the case of the dam relicensing process, they would be more detailed cost analysis of the different alternatives. The authors also advice to focus on the study of the decision-process itself as it can deeply influence the social preferences and the outcomes for ecosystems. Gowan et al. (2006) **therefore seem to think that economic valuation of either the ecosystem that has to be protected or the economic activities that threaten it is not appropriate and that it is more important to sharpen the tools to advocate for ecosystem-friendly solutions, considering that the restoration of ecosystem anyway represents a goal that**

has to be pursued on ethical ground.

Are ecosystem valuation studies necessary to make informed decision regarding ecosystem services ? The question is asked by Gowan et al. (2006). They demonstrate that in the case of the Elwha barrage removal in the US decided in 1992, decision makers did not have any ecosystem services valuation study at hand, and still they took a decision to improve the ecosystem's situation. The valuation of ecosystem benefits and of the willingness of citizen to pay for the removal of the dams and the restoration of the ecosystem state came only later in 1996. They argue that it is a general case and that “*ecosystem valuation rarely will be employed when making the case for ecosystem-enhancing measures.*” (Gowan et al. 2006, p.509)

In this second case study, another dam represents the *incompatible* (relative to a reference of restoration of the majority of the native salmon species of the Elwha river) *adversary of biodiversity*, it presents very *high opportunity costs* and it is a regulatory decision (from Congress) that eventually tips the balance in favour of the environment and forces it to stop its activity. That follows what we described: *high opportunity costs* are likely to require regulatory tools to be forced to change. And this case study also illustrates that against *high profits* driver such as this dam, economic valuations of the drivers do not constitute very powerful tools either. Gowan et al. (*op. cit.*) even seem to think usual costs-benefits economic valuation of either the adversary or of the biodiversity of concern are not useful advocacy tools, and that none will be employed by decision-makers. He advice the development and use of “*analytical contributions*” (*ibid.*, p.521) that can be grasped and used more easily by decision-makers. That is what we try to achieve through the analytical accountancy we developed in **Chapter 2**.

Apendix C. Comparison of spendings for productivity and to protect biodiversity in agriculture

The following table gives an idea of the difference between subsidies and compensation. Data are far from perfect since, among other things, the total arable land considered dates from 2009 whereas the subsidy amounts date from 2011. If not stated in footnote, data come from our fieldwork in Hunchun.

Table 18- Comparison of amounts spent on subsidies for productivity or for biodiversity conservation.

	Subsidies for productivity		Spending for biodiversity conservation	
Known subsidies (RMB)	(1) Total arable land	28322 ha ³⁵	(1) Compensation for tiger related loss	345,300
	(2) Subsidy for growing crops	1050 /ha	(2) Compensation for wild goose related loss	2,156,455.8
	(3) Subsidy for seeds	150 /ha	(3) Compensation for other loss (wild boar, ground squirrel)	404,969
	Total = (1)*((2)+(3))	33,986,400	Total compensation = (1)+(2)+(3)	2,906,724.8
Unknown subsidies³⁶	Support to buy tractors	Loans to buy tractors and possibly subsidy to fuel, no figure for this. Likely to be substantial.	Spending for the Grain for Green programme	Unevaluated but likely to be very low (less than 5% of area engaged in the programme in Chunhua) ³⁷ .

Compensation represents less than 10% of the amount spent in subsidies to increase agriculture output. But still, public authorities are reportedly running out of money. Is biodiversity that unimportant to them ? It however needs to be profoundly qualified: money for subsidies and money for compensation do not come from the same source, the first comes from the State whereas the second comes from the city and the province.

Data from France's Hautes Alpes (Direction Départementale des Territoires des Hautes – Alpes 2010) similarly show that spending for compensation is dwarfed by other subsidies to agriculture: in 2010. There, compensations to farmers for damage by wolves represent only 161,790 € in 2010,

³⁵ From Hunchun's Government (2009)'s 2009 data of arable land at the beginning of the year.

³⁶ We lacked time to collect relevant data for these subsidies.

³⁷ Sources: Chunhua's government and Hunchun's Government (2009).

whereas total European Union's Common Agricultural Policy subsidies (some of them directed to environmental-friendly practices though) amount to about 40 millions €. Even when we add the 831,060.71 € given as support for prevention measures, wolf-related spendings still amount to less than 3% of total agricultural subsidies.

Index lexical

Activity.....	
Compatible.....	42
Incompatible.....	42
Synergistic.....	42
Adversaries of biodiversity.....	18
Advocates.....	40
Analytical accountancy.....	22
Apparent costs.....	53
Assessment.....	
Inaccuracy.....	99
Inadequacy.....	99
Incompleteness.....	99
Auxiliary.....	40
Basic assumptions.....	50
Biased science.....	27
Biodiversity.....	
Exceptional.....	91
General.....	91
Non-use value.....	92
Ordinary.....	91
Use value.....	92
Breadwinner.....	40
City.....	106
Domestic city.....	106
Merchant city.....	106
Collective (the).....	29
Conservative scenario (the).....	71
Current activity.....	41
Dashboard.....	55
Decisive assessment.....	93
Dogmatism.....	27
Drivers.....	39
Economic value of the ecosystem.....	105
Effective management.....	39
Environmental costing.....	93
Facts.....	27
Future activity.....	41
Harmful.....	80
Hidden agenda.....	28
High (cost).....	41
Highness.....	106
Incentive.....	39, 80
Efficient.....	107
Failed incentives.....	108
Perverse incentives.....	80

Relevant.....	107
Informative assessment.....	93
Intensive.....	42
Intentional management.....	39
Interests.....	21
Low (cost).....	41
Market anomaly.....	40
Market failure.....	80
Mixing facts and values.....	27
Model.....	
Collective action issue model.....	21
Decision system model.....	22
Environmental issue model.....	21
More realist assumptions.....	50
Naming and shaming.....	97
Negotiable compatibility.....	72
Non conducive regulatory framework.....	100
Opportunity cost.....	41
Policy advocate.....	30
Policy failure.....	80
Protectors.....	40
Rationality.....	24
Real costs.....	53
Real profits.....	53
Regulating actor.....	39
Remittances.....	64
Sector-based actor.....	39
Self sustainable population.....	33
Slow scenario (the).....	71
Social optimum.....	80
Source (of gain or loss).....	61
Strategic environmental actor.....	39
Strategic environmental management analysis.....	20
Subsidy.....	80
Perverse subsidy.....	83
Technical assessment.....	93
Trials.....	106
Values.....	27
Protected value.....	27
Reference objective.....	32
Value neutral.....	31
Windfall.....	40